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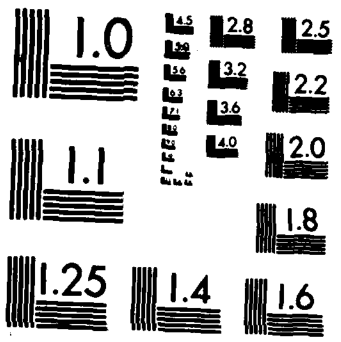
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Volume III

CADS - A COMPUTER AIDED DESIGN SYSTEM
Volume III - Program Maintenance Manual

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This is the program maintenance manual for the Computer Aided Design System, "CADS." CADS is a pre and post processor for structural analysis and optimization programs based on the finite element method. The system supports five functional modules controlled by an Executive Monitor. All of these modules communicate with a data base through a data manager. In addition a post output translator, CADSPP, is available which processes output from finite element programs, e.g. NASTRAN, directly into the data base. This report gives a detailed description of the internal structure of CADS for use in future maintenance and enhancement of the code. CADS uses two random access files to store the geometry and analysis program results for a finite element model. The geometry (GEOM) data base is used to store all the elements, grid points, and similar model information. The POST data base is used to store analysis results such as element stresses and forces, grid displacements and modal output. Detailed descriptions of the individual data records for the GEOM and POST data bases are given. In addition each subroutine or function is described. (CONTINUED ON REVERSE SIDE)

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BLOCK 19. CONTINUED

Subroutine descriptions include an outline of its purpose and approach, routine inputs and outputs, error messages, external calls, the argument list, a key variable list and a list of common blocks. A brief discussion on the installation of CADS is also included.

FOREWORD

This final report was prepared by Rockwell International, North American Aircraft Operations (NAAO), El Segundo, California for the Structures and Dynamics Division, Flight Dynamics Laboratory, (FDL) Wright-Patterson Air Force Base, Dayton, Ohio. The work was performed under Contract No. F33615-81-C-3229 which was initiated under Project No. 2401. Mrs. V. Tischler was the FDL project engineer for this effort.

The Development of A Computer-Aided Design System (CADS) contract was a 40-month effort with this final report consisting of three volumes: Volume I, "Final Summary Report," presents an overview of the CADS software capabilities; Volume II, "User's Guide," contains the detailed instructions for each of the commands in the CADS software; Volume III, "Program Maintenance Manual," describes the internal structure of CADS for use in future maintenance and enhancement of the code.

The Rockwell program manager for this effort was Mr. M. C. Less, NAAO Advanced Structures and Materials Department. He was supported by Mrs. S. Manuel of the same department.

The work described in this report was begun in December 1981 and completed in May 1985. This report was submitted for publication in May 1985.

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TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

1.0 INTRODUCTION

The widespread use of a large variety of finite element (FE) analysis codes to perform structural analysis tasks has focused attention on a common Air Force and industry problem: the relatively large amount of time and effort required to perform data preparation, data validation, and resultant FE analysis tasks with existing state-of-the-art codes. This problem is further aggravated by the relatively slow, interactive response of mainframe time-sharing computer processing systems. To reduce time and effort, a computer-aided, advanced interactive graphics, minicomputer-based, finite element modeling system has been developed. This system includes mesh generation and validation capabilities as preprocessing functions as well as interactive graphic features for postprocessing the analysis code output data.

The Computer Aided Design System (cADS) software's most important aspects are that it is targeted for 32-bit minicomputer hardware, makes use of FORTRAN 77 and device independent graphics, and supports the definition of composite material elements. The CADS program utilizes VAX 11/780 hardware with secondary testing for transportability, having been performed on IBM 4341 and PRIME 850 hardware. CADS is modular in nature with various functional modules accessed through a common executive monitor and makes use of common data base routines, as shown in Figure 1.

The contract, F33615-81-C-3229, was initiated in December 1981 and completed in May 1985 with this final report. Volume I, "Final Summary Report," presents an overview of the CADS software capabilities; Volume II, "User's Guide," and Volume III, "Program Maintenance Manual," give detailed user instruction and source code descriptions of the CADS software. these three volumes make up the final documentation of the CADS software.

This program Maintenance Manual contains information concerning the data bases, error handling, and installation procedures for the CADS and CADSPP programs. However, the majority of this manual is the detailed subroutine descriptions for the CADS and CADSPP software.

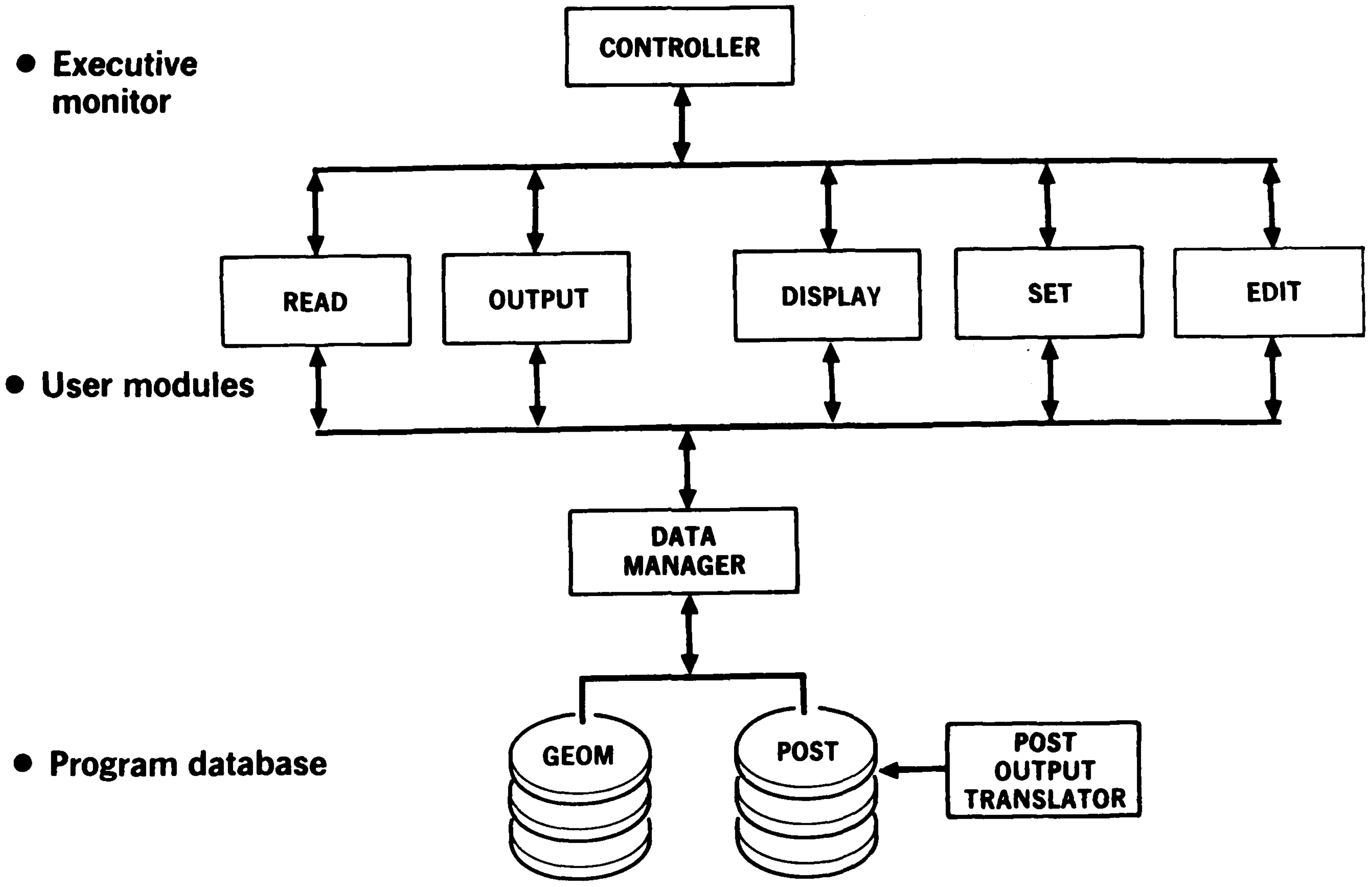


Figure 1. Modular Nature of CADS Software

2.0 INSTALLATION

The installation of the CADS software requires the loading of the CADS files to on-line disk storage. Depending on the hardware being used, the program source may have to be compiled and linked. Details of the necessary procedures are provided in the following paragraphs.

2.1 STANDARD SOURCE TAPE (VAX SYSTEM)

The CADS software is generally supplied as a standard 9-track, 1600 bpi magnetic tape containing a number of different files. It is created using the standard VAX/VMS COPY command to copy the original VAX files to the tape. The file numbers, names, and descriptions are given in Table 1. The source code, object decks, compiled listings, and test data files for the software are supplied. The VAX/VMS MOUNT and COPY commands are used to load the CADS files from the tape to disk. The MOUNT command is used to mount and attach the tape to a drive. The tape is VAX labeled as CADS and should be mounted on drive MTAØ. Once mounted, the command

```
COPY MTAØ:CADSCOPY.COM  CADSCOPY.COM
```

will copy the first file from the tape to disk. This CADSCOPY.COM command file can then be executed to copy the remaining files from tape to disk. In all cases the files are named as given in Table 1. The CADSCOPY.COM file is listed in Figure 2.

After these files are on the disk, the CADS software is ready for link-editing and user testing. This is a straightforward process using the VAX LINK command. The library name for the DI-3000 graphics package is required in order to link the software for execution. This name is used with the /LIBR keyword of the LINK command to resolve the DI-3000 graphics package call statements. If the DI-3000 package has been installed following the standard vendor directions the link can be performed using the following command:

```
DI3LOAD  CADSV11,CADSV12,CADSV13,CADSV14,CADSV15,  T14
```

This command will link the CADS object decks (files 8-12, Table 1) with the correct DI-3000 core routines and Tektronix 4014 device driver. After linking the CADS object decks basic test cases should be executed to ensure that the executable load module is ready for general use. The CADSPP object deck should now be linked. It does not use auxilary libraries. The software can be released for general use once this testing is complete.

TABLE 1

VAX SUPPLIED CADS FILES

Number	Name	Description
1	CADSCOPY.COM	Command file to copy the remaining files
2	CADSV11.FOR	CADS source code by alphabetic routine name
3	CADSV12.FOR	
4	CADSV13.FOR	
5	CADSV14.FOR	
6	CADSV15.FOR	
7	CADSPP.FOR	CADSPP source code
8	CADSV11.OBJ	Object decks for source code
9	CADSV12.OBJ	
10	CADSV13.OBJ	
11	CADSV14.OBJ	
12	CADSV15.OBJ	
13	CADSPP.OBJ	
14	CADSV11.LIS	Compiled listings for source code
15	CADSV12.LIS	
16	CADSV13.LIS	
17	CADSV14.LIS	
18	CADSV15.LIS	
19	CADSPP.LIS	
20	NATUIN1.DAT	NATURAL generator input test cases
21	NATUIN2.DAT	
22	NATUIN3.DAT	
23	NASTIN1.DAT	NASTRAN bulk input test cases
24	NASTIN2.DAT	
25	NASTIN3.DAT	
26	ANALIN.DAT	ANALYZE bulk input test case
27	OPTIN.DAT	OPTSTAT bulk input test case
28	NASTBULK.DAT	NATUIN1 output as NASTRAN data
29	ANALBULK.DAT	NATUIN3 output as ANALYZE data
30	OPTBULK.DAT	NATUIN2 output as OPTSTAT data
31	NASTOUT3.DAT	NASTRAN analysis file output for input NASTIN3.DAT
32	ANALOUT.DAT	ANALYZE analysis file output
33	OPTOUT.DAT	OPTSTAT analysis file output
34	CADSCOMP.COM	Compiles and links CADS source

```
$ ALLOC     MTAØ:
$ MOUNT     MTAØ:  CADS
$ COPY      MTAØ:CADSCOPY.COM     CADSCOPY.COM     /LOG
$ COPY      MTAØ:CADSV11.FOR      CADSV11.FOR      /LOG
$ COPY      MTAØ:CADSV12.FOR      CADSV12.FOR      /LOG
$ COPY      MTAØ:CADSV13.FOR      CADSV13.FOR      /LOG
$ COPY      MTAØ:CADSV14.FOR      CADSV14.FOR      /LOG
$ COPY      MTAØ:CADSV15.FOR      CADSV15.FOR      /LOG
$ COPY      MTAØ:CADSPP.FOR       CADSPP.FOR       /LOG
$ COPY      MTAØ:CADSV11.OBJ      CADSV11.OBJ      /LOG
$ COPY      MTAØ:CADSV12.OBJ      CADSV12.OBJ      /LOG
$ COPY      MTAØ:CADSV13.OBJ      CADSV13.OBJ      /LOG
$ COPY      MTAØ:CADSV14.OBJ      CADSV14.OBJ      /LOG
$ COPY      MTAØ:CADSV15.OBJ      CADSV15.OBJ      /LOG
$ COPY      MTAØ:CADSPP.OBJ       CADSPP.OBJ       /LOG
$ COPY      MTAØ:CADSV11.LIS      CADSV11.LIS      /LOG
$ COPY      MTAØ:CADSV12.LIS      CADSV12.LIS      /LOG
$ COPY      MTAØ:CADSV13.LIS      CADSV13.LIS      /LOG
$ COPY      MTAØ:CADSV14.LIS      CADSV14.LIS      /LOG
$ COPY      MTAØ:CADSV15.LIS      CADSV15.LIS      /LOG
$ COPY      MTAØ:CADSPP.LIS       CADSPP.LIS       /LOG
$ COPY      MTAØ:NATUIN1.DAT      NATUIN1.DAT      /LOG
$ COPY      MTAØ:NATUIN2.DAT      NATUIN2.DAT      /LOG
$ COPY      MTAØ:NATUIN3.DAT      NATUIN3.DAT      /LOG
$ COPY      MTAØ:NASTIN1.DAT      NASTIN1.DAT      /LOG
$ COPY      MTAØ:NASTIN2.DAT      NASTIN2.DAT      /LOG
$ COPY      MTAØ:NASTIN3.DAT      NASTIN3.DAT      /LOG
$ COPY      MTAØ:ANALIN.DAT       ANALIN.DAT       /LOG
$ COPY      MTAØ:OPTIN.DAT        OPTIN.DAT        /LOG
$ COPY      MTAØ:NASTBULK.DAT     NASTBULK.DAT     /LOG
$ COPY      MTAØ:ANALBULK.DAT     ANALBULK.DAT     /LOG
$ COPY      MTAØ:OPTBULK.DAT      OPTBULK.DAT      /LOG
$ COPY      MTAØ:NASTOUT3.DAT     NASTOUT3.DAT     /LOG
$ COPY      MTAØ:ANALOUT.DAT      ANALOUT.DAT      /LOG
$ COPY      MTAØ:OPTOUT.DAT       OPTOUT.DAT       /LOG
$ COPY      MTAØ:CADSCOMP.COM     CADSCOMP.COM     /LOG
$ DIR
$ DISMOUNT  MTAØ:
```

Figure 2. CADSCOPY.COM File Listing

2.2 NON-VAX SOURCE TAPE

The CADS software is also available as source code and example data decks in card image format on magnetic tape for installation on non-VAX hardware. The files supplied for non-VAX systems are described in Table 2. The files are supplied as an unlabelled, 1600 bpi, 9-track, fixed block, multi-file magnetic tape. The blocks contain 20 records of 80 bytes (1 card) each with each file listed in Table 2 making up a separate tape file.

TABLE 2

NON-VAX SUPPLIED CADS FILES

Number	Name	Description
1	CADSV11.FOR	
2	CADSV12.FOR	
3	CADSV13.FOR	CADS source code by alphabetic routine name
4	CADSV14.FOR	
5	CADSV15.FOR	
6	CADSPP.FOR	CADSPP source code
7	NATUIN1.DAT	
8	NATUIN2.DAT	NATURAL generator input test cases
9	NATUIN3.DAT	
10	NASTIN1.DAT	
11	NASTIN2.DAT	NASTRAN bulk input test cases
12	NASTIN3.DAT	
13	OPTIN.DAT	OPTSTAT bulk input test case
14	ANALIN.DAT	ANALYZE bulk input test case
15	NASTOUT3.DAT	NASTRAN analysis file output for input NASTIN3.DAT
16	OPTOUT.DAT	OPTSTAT analysis file output
17	ANALOUT.DAT	ANALYZE analysis file output
18	NASTBULK.DAT	NATUIN1 output as NASTRAN data
19	OPTBULK.DAT	NATUIN2 output as OPTSTAT data
20	ANALBULK.DAT	NATUIN3 output as ANALYZE data

2.3 DESCRIPTIONS OF FILES

The CADSCOPY.COM file is a command list which copies the remaining tape files to an on-line disk. CADSV11.FOR through CADSV15.FOR files are the source code for the CADS software. These files contain all of the CADS routines in alphabetical order with approximately 4500 source statements per file. The CADSPP.FOR file contains the source statements for the CADSPP program routines in alphabetical order. The CADSV11.OBJ through CADSPP.CBJ files contain the object decks of the respective compiled source files, while CADSV11.LIS through CADSPP.LIS contain the compiled listing files.

A series of test data files are contained in the next 14 files. These files were used to test the CADS software while it was in development and provided the examples for the Volume II "Users Guide" sample sessions. The NATUIN1.DAT through NATUIN3.DAT files contain NATURAL generation data test cases. The NASTIN1.DAT through NASTIN3.DAT are NASTRAN bulk data decks while the OPTIN.DAT and ANALIN.DAT files contain OPTSTAT and ANLAYZE input bulk data decks respectively. The NASTOUT3.DAT through ANALOUT.DAT files are output files containing finite element analysis results for input to CADSPP. The NASTBULK.DAT, OPTBULK.DAT, and ANALBULK.DAT are files which contain bulk data decks from CADS of the NATUIN1.DAT through NATUIN3.DAT data, respectively.

Finally, the last file is a command file which will compile the CADS and CADSPP source on the VAX and link them into executable files named CADS.EXE and CADSPP.EXE. This command file assumes that the DI-3000 graphics library is available to the user name performing the compilation.

3.0 CADS MAINTENANCE

The CADS software has been extensively documented internally through the use of comment statements embedded in the source code. The code is standard FORTRAN 77 and has proven readily transportable in the past. The only known system-dependent problem concerns the use of the record length parameter on the OPEN statement. IBM uses bytes for this parameter while DEC, PRIME, and CDC use words for the record length. In section 5.0 overview descriptions of each of the CADS subroutines are provided.

The general purpose, hidden line program developed by NASA and available through COSMIC (reference 3) was used to provide the basis for the CADS hidden line functions. Those routines have proven to be fairly stable; however, any problems encountered in them can be reported to COSMIC for evaluation and distribution to other users.

The DI-3000 device independent graphics package, from Precision Visuals, Incorporated (PVI), has been used to provide the interactive graphics functions for CADS. This proprietary, commercially available, package is maintained and supported by PVI. The individual installation license for DI-3000 would contain details of support for that installation. CADS uses release 4.0 of DI-3000.

Generally, the CADS code would be stored on a system disk accessible to those responsible for configuration control of the software for the user community. Changes and enhancements made to the code would typically be made on a routine-by-routine basis with validation testing before release for production use. For this reason, it would be efficient to store the CADS code as a library so that routines can be changed, compiled, and relinked on an individual basis. The executable would be stored as a file which would be accessible to all users. It should also have a test version for use in validation and verification testing. The standard DEC, IBM, or other system commands and procedures should be used to make the library, perform editing on the routines, recompile, and relink the code.

4.0 DATA BASE DESCRIPTION

4.1 BACKGROUND

The CADS program uses two random access files to store the geometry information and analysis program output results for a finite element model. The geometry (GEOM) data base is used to store all of the element, grid point, and similar model information. It is the data base required for the display and pre-processing CADS activities. It will be generated by CADS when an existing GEOM data base is not available.

The second data base is used for the display of various analysis program results. This is the POST data base and contains the element stresses and forces and the grid displacements and eigenvectors depending upon the user request and analysis program. This data base is generated by the CADSPP program for use by the CADS program.

Each data base is laid out in the same basic format of a master record pointing to header records, which in turn, point to the actual data records. Both data bases are accessed by the same set of input/output routines; IOHEAD, IOPAC, and IODB. The IODB routine performs the actual Fortran READ/WRITE direct access I/O functions on the data bases. The IOPAC routine packs and unpacks data arrays of multi-record information for I/O to the data base. The IOHEAD routine takes care of the header record information and full data base copy functions.

4.2 GEOMETRY DATA BASE

The geometry (GEOM) data base is attached to unit 1 during the CADS program execution. It can be saved as a permanent file for use in later sessions depending upon the user requirements. Each record contains 990 words of information which in turn depend upon the particular types of data being read into CADS and stored to the data base. These records are not stored in any particular order on the data base and their location depends upon the order of information fed into CADS during the READ module operations. That is, the GEOM data base is not specifically blocked so that certain sections contain only element materials and other sections contain only node coordinates and so on.

However, if all of the node data is read in or generated, and then all of the element data is defined then the resulting GEOM data base records will be packed one after the other.

Detailed descriptions of the individual data records for the GEOM data base are given in the following paragraphs. The order of the records is arbitrary with the obvious restriction that the correct pointers to the data records be stored in the appropriate header and master records so that the data elements may be retrieved as needed.

4.2.1 GEOM MODEL HEADER RECORD

The first record in the GEOM data base is the model header record. It has provisions for various model data and contains pointers to the node and element data stored in the data base. Table 3 lists the individual data elements of the model header. The pointers in the record point to the node and element data headers described next.

4.2.2 NODE DATA HEADER RECORD

The node header record is listed in Table 4. It is made up of a series of 14 word pointer key sets which point to the various types of node data or attributes stored for a particular model. For example, the fourth word points to the base coordinate system data for the nodes defined in this set of keys. CADS can use this key to go pick up the base coordinate information when it is required for displays and/or output.

4.2.3 NODE DATA RECORDS

The actual node data components are stored in various data records. Each record is 990 words long and is split into different sized matrices depending upon the data components being stored. Table 5 lists the components in each of these different node data records.

TABLE 3

GEOM MODEL HEADER

WORD	NAME	DESCRIPTION
1-2	DATELA	Date of Last Access
3-4	DATEMC	Date Model was Created
5-6	TIMELA	Time of Last Access
7-8	NAMELU	Name of Last User (not-used)
9-10	NAMEUC	Name of Model Creator (not-used)
11-18	TITLE	Model Title
19	NSUB	Number of Model Substructures
20	NVRLA	Next Valid Record Number
21-22	NAMESH	Substructure Name (not-used)
23	NOSUBH	Substructure Number (not-used)
24	NODREC	Number of Node Header Record
25	NGEMP	Number of Element Header Record
26	NGROUP	Number of Substructure Element Groups
27	NONODE	Number of Substructure Nodes
28	MXNODE	Highest Node Number
29	NELMOD	Number of Model Elements
30	NTNODE	Number of Model Nodes

NOTE: Words 21 through 30 repeat for each substructure to a total of 97 substructures for the model.

TABLE 4

NODE HEADER RECORD

WORD	NAME	DESCRIPTION
1	NODE	First Node Number in Data Record
2	NODEL	Last Node Number in Data Record
3	NODENO	Number of Nodes in Data Record
4	KBSYS	Key to Base Coordinate Data
5	KINSYS	Key to Input Coordinate Data
6	KNODE	Key to Node IDs and Constraints
7	KLOAD	Key to External Load Data
8	NLOAD	Number of External Loads
9	KMOMNT	Key to External Moment Data
10	NMOMNT	Number of External Moments
11	KCOORD	Key to Coordinate System Data
12	KSEQGP	Key to NASTRAN SEQGP Data
13	KSPC1	Key to NASTRAN SPC1 Data
14	LCNO	Case Number for Loads/Moments

NOTE: Words 1 through 14 repeat up to 39 times as needed to meet the node data requirements. This provides for a total of some 12,000 nodes per model.

TABLE 5

NODE DATA RECORDS

WORD	NAME	DESCRIPTION
1	X	Base Coordinate System X Value
2	Y	Base Coordinate System Y Value
3	Z	Base Coordinate System Z Value
1	X,R,R	Input System - First Axis Value
2	Y,T,T	Input System - Second Axis Value
3	Z,Z,P	Input System - Third Axis Value
1	ID	Node Identification Number
2	NCONT	Packed Switch of Constraints
3	NCNTC	Constraint Coordinate System ID
1	ID	Node Identification Number
2	SEQGP	NASTRAN SEQGP Number
3	CP	Node Coordinate System Number

NOTE: Words 1-3 are repeated up to 330 times per data record until each node has a set of base coordinate values.

WORD	NAME	DESCRIPTION
1	SID	Case Identification Number
2	NODE	Node Number for External Force
3	CID	Coordinate System of Force
4	SCALE	Scale Factor for Force Vector
5	X	Force Vector Direction - X
6	Y	Force Vector Direciton - Y
7	Z	Force Vector Direction - Z

NOTE: Words 1-7 are repeated up to 141 times per data record until all of the external load or moment values have been stored.

TABLE 5 (Continued)

NODE DATA RECORDS

WORD	NAME	DESCRIPTION
1	CID	Coordinate System Id. Number
2	ISYS	Coordinate System Type Switch -1=Rect., -2=Cyl., -3=Sphere.
3	NODE1	First System Definition Node
4	NODE2	Second System Definition Node
5	NODE3	Third System Definition Node
6-12	Blank	Not Used

WORD	NAME	DESCRIPTION
1	CID	Coordinate System Id. Number
2	ISYS	Coordinate System Type Switch 1=Rect., 2=Cyl., 3=Sphere.
3	RID	Reference Coordinate Number
4	A1	First System Definition Vector
5	A2	
6	A3	
7	B1	Second System Definition Vector
8	B2	
9	B3	
10	C1	Third System Definition Vector
11	C2	
12	C3	

Note: Words 1-12 are repeated up to 82 times per data record until all of the coordinate system data is defined.

WORD	NAME	DESCRIPTION
1	SID	SPC1 Set Identification Number
2	ICONT	Packed Word of Constraint Switch
3	NONODE	Number of Nodes with ICONT
4-n	NODES	Node Numbers of SPC1 Set Nodes

Note: Words 1-n are repeated until the SPC1 set is defined using up to 990 words per data record.

4.2.4 ELEMENT HEADER RECORD

The element header record maintains the pointers to the element attributes, such as the connectivity, sizes, and materials. These pointers are then used to retrieve the specific data records containing the requested data elements. This header/pointer procedure reduces data retrieval times since the software just has to search one pointer and one data record for a specific piece of data. Without the pointer procedure the entire set of element data records would have to be searched for a specific piece of data. Table 6 describes the element header record details.

4.2.5 ELEMENT DATA RECORDS

The element data records are described in Table 7. These records contain the connectivity information for the elements being stored.

4.2.6 PROPERTY DATA RECORDS

The property data records are described in Table 8. These records contain the size or property values for the property tables. These tables are used to apply the size data to the individual elements and are referenced by the individual element connectivity data records.

4.2.7 MATERIAL DATA RECORDS

The material data records are described in Table 9. These records contain the material component values for the material tables defined for the model. They are pointed to by the individual element connectivity data records to specify the materials of a particular element.

4.3 POST DATA BASE

The POST data base contains the results of an analysis program execution as stored by the CADSPP program for use in the CADS program. It uses the pointer record concept like the GEOM data base and contains four types of data records. The first two are the grid displacement and eigenvector data record types while the second two contain the element stress and forces data types.

TABLE 6

ELEMENT HEADER RECORD

WORD	NAME	DESCRIPTION
1	NGRP	Group Number of the Elements
2	NETYPE	Element Type for the Group
3	NEL	Number of Elements in the Group
4	KECON	Key to Connectivities for the Group
5	KEID	Key to Element Numbers for the Group
6	KPROP	Key to Properties for the Group
7	MNNODE	Minimum Node Number in the Group
8	MXNODE	Maximum Node Number in the Group
9	KEYEX	Key to Extra BEAM or Layer Data

Note: Words 1-9 are repeated up to 99 times per data record until each group in the model has been defined.

10,1	KM1	Key to MAT1 Material Table
10,2	NM1	Number of MAT1 Table Entries
10,11	KM2	Key to MAT2 Material Table
10,12	NM2	Number of MAT2 Table Entries
10,41	KM4	Key to MAT4 Material Table
10,42	NM4	Number of MAT4 Table Entries
10,51	KM5	Key to MAT5 Material Table
10,52	NM5	Number of MAT5 Table Entries
10,61	KMC	Key to MATC Material Table
10,62	NMC	Number of MATC Table Entries

Note: Words in column ten of the element header record (i.e., 10,1 and 10,2, etc.) are used to point to the material property tables for the elements.

TABLE 7

ELEMENT DATA RECORDS

WORD	NAME	DESCRIPTION
1	EID	Element Number
2	MID	Material Number for Element
3	KMAT	Key to the Material Data Record
4	MATOFF	Offset in Record for Material
1	EID	Element Number
2	NANG	Number of Angles for the Element
3	KMAT	Key to Composite Material Table
4	LINOFF	Key/Offset to the Layer Data

Note: Repeat words 1 to 4 up to 240 times per data record to specify the element materials for the model group now being defined.

WORD	NAME	DESCRIPTION
1	NLAY	Number of Plies for this Angle
2	COID	Composite Material ID for Angle
3	LA	Orientation Angle
4	MINL	Minimum Number of Plies for Angle
5	MAXL	Maximum Number of Plies for Angle

Note: Repeat words 1 to 5 up to 198 times per data record to specify each layer angle for each composite element of the model group being stored. The key/offset pointer gives the record number and start position of the data for this element.

WORD	NAME	DESCRIPTION
1	B2CID	PIPE Element Continuation Number
2	PA	Pin Flag for PIPE Element
3	PM	Moment Pin Flag for PIPE Element

Note: Repeat words 1 to 3 up to 330 times per data record to store continuation data for PIPE elements.

WORD	NAME	DESCRIPTION
1	BCID	BAR Element Continuation Number
2	PA	Pin Flag at end A for BAR Element
3	PB	Pin Flag at end B for BAR Element
4	Z1A	
5	Z2A	Bar Offsets at end A
6	Z3A	
7	Z1B	
8	Z2B	Bar Offsets at end B
9	Z3B	

Note: Repeat words 1 to 9 up to 110 times per data record to store continuation data for BAR elements.

TABLE 7 (Continued)

ELEMENT DATA RECORDS

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number

Note: Repeat words 1 to 2 up to 495 times per data record to specify the element connectivity for two noded groups of elements.

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number

Note: Repeat words 1 to 3 up to 330 times per data record to specify the element connectivity for three noded PIPE elements.

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number
4	TH	Material Orientation Angle

Note: Repeat words 1 to 4 up to 247 times per data record to specify the element connectivity for three noded triangular elements.

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Bar Axis Vector Direction Node
4	CBOFF	Bar Offset Information Pointer

Note: Repeat words 1 to 4 up to 247 times per data record to specify the element connectivity for the two noded BAR elements.

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number
4	G4	Fourth Connectivity Node Number

Note: Repeat words 1 to 4 up to 247 times per data record to specify the element connectivity for the four noded shear, twist, and tetrahedron elements.

TABLE 7 (Concluded)

ELEMENT DATA RECORDS

WORD	NAME	DESCRIPTION
1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number
4	G4	Fourth Connectivity Node Number
5	TH	Material Orientation Angle

Note: Repeat words 1 to 5 up to 198 times per data record to specify the element connectivity for the four noded quadrilateral plate and membrane elements.

1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number
4	G4	Fourth Connectivity Node Number
5	G5	Fifth Connectivity Node Number
6	G6	Sixth Connectivity Node Number
7	TH	Material Orientation Angle

Note: Repeat words 1 to 7 up to 141 times per data record to specify the element connectivity for six noded TRIM6 higher order triangular membrane elements.

1	G1	First Connectivity Node Number
2	G2	Second Connectivity Node Number
3	G3	Third Connectivity Node Number
4	G4	Fourth Connectivity Node Number
5	G5	Fifth Connectivity Node Number
6	G6	Sixth Connectivity Node Number
7	G7	Seventh Connectivity Node Number
8	G8	Eighth Connectivity Node Number
9	TH	Material Orientation Angle

Note: Repeat words 1 to 9 up to 110 times per data record to specify the element connectivity for eight noded QM8 higher order quadrilateral membrane elements.

1	G1-G20	Connectivity Node Numbers 1-20 for the WEDGE, HEX1, and HEX2 Elements

Note: Repeat words 1 to 20 to define the solid element types for the model. Up to 165, 123, or 49 elements can be defined per data record depending upon the number of nodes required to specify the given element type. For instance 123 eight noded HEX1 elements can be defined, or 49 twenty noded HEX2 elements, or 165 six noded WEDGE elements.

TABLE 8

PROPERTY DATA RECORDS

WORD	NAME	DESCRIPTION
1	A	Cross-Sectional Rod Area
2	J	Torsional Constant for Rod
3	C	Torsional Stress Coefficient
4	NSM	Non-Structural Mass
5	MIN	Minimum Area
6	MAX	Maximum Area

Note: Repeat words 1 to 6 up to 165 times per data record to specify the axial rod properties for these elements.

WORD	NAME	DESCRIPTION
1	T1	Thickness at Node 1
2	T3	Thickness at Node 3
3	T5	Thickness at Node 5
4	NSM	Non-Structural Mass
5	MIN	Minimum Thickness
6	MAX	Maximum Thickness

Note: Repeat words 1 to 6 up to 165 times per data record to specify the 6-noded triangular membrane properties.

WORD	NAME	DESCRIPTION
1	T	Element Thickness
2	NSM	Non-Structural Mass
3	MIN	Minimum Thickness
4	MAX	Maximum Thickness

Note: Repeat words 1 to 4 up to 247 times per data record to specify the properties for the membrane, shear, twist, and type 2 (CQUAD2, CTRIA2) bending elements.

WORD	NAME	DESCRIPTION
1	T1	Membrane Sheet Thickness
2	MID2	Material number for Bending
3	I	Area Moment of Inertia
4	MID3	Material number for Transverse Shear
5	T3	Transverse Shear Thickness
6	NSM	Non-Structural Mass
7	Z1	Fiber Distance - 1 Side
8	Z2	Fiber Distance - 2 Side
9	MIN	Minimum T1 Thickness
10	MAX	Maximum T1 Thickness

Note: Repeat words 1 to 10 up to 99 times per data record to specify the properties for the TRIA1 and QUAD1 bending elements.

TABLE 8 (Continued)

PROPERTY DATA RECORDS

WORD	NAME	DESCRIPTION
1	T1	Thickness at Node 1
2	T3	Thickness at Node 3
3	T5	Thickness at Node 5
4	T7	Thickness at Node 7
5	NSM	Non-Structural Mass
6	MIN	Minimum Thickness
7	MAX	Maximum Thickness

Note: Repeat words 1 to 7 up to 141 times per data record to specify the values for 8-noded quadrilateral elements.

1	K	Scalar Spring Value
2	GE	Damping Coefficient
3	S	Stress Coefficient

Note: Repeat words 1 to 3 up to 330 times per data record to specify the properties for the ELAS spring elements.

1	CID	Coordinate System ID for Element Material Reference System
2	NIP	No. of Integration Points/Side
3	AR	Maximum Aspect Ratio
4	ALFA	Maximum Angle Between Normals of two Subtriangles of a Face
5	BETA	Maximum Angle Between the Vector Connecting a Corner Point to an Adjacent Midside Point and the Vector Connecting that Point to the Other Midside or Corner Point.

Note: Repeat words 1 to 5 up to 198 times per data record to specify the properties for the CIHEX1 and CIHEX2 solid elements.

TABLE 8 (Continued)

PROPERTY DATA RECORDS

WORD	NAME	DESCRIPTION
1	OD	Outside Diameter of PIPE
2	T	PIPE Wall Thickness
3	NSM	Non-Structural Mass
4	P	Internal Pressure
5	C1	
6	C2	
7	D1	
8	D2	
9	E1	Stress Recovery Coefficients
10	E2	
11	F1	
12	F2	
13	MIN	Minimum OD Value
14	MAX	Maximum OD Value

Note: Repeat words 1 to 14 up to 70 times per data record to specify the properties for the PIPE elements.

WORD	NAME	DESCRIPTION
1	A	Cross-Sectional Area of BAR
2	I1	Area Moment of Inertia - 1
3	I2	Area Moment of Inertia - 2
4	J	Torsional Constant
5	NSM	Non-Structural Mass
6	C1	
7	C2	
8	D1	
9	D2	
10	E1	Stress Recovery Coefficients
11	E2	
12	F1	
13	F2	
14	K1	Area Factor for Shear - 1
15	K2	Area Factor for Shear - 2
16	I12	Area Moment of Inertia
17	MIN	Minimum A Value
18	MAX	Maximum A Value

Note: Repeat words 1 to 18 up to 55 times per data record to specify the properties for the BAR elements.

TABLE 8 (Concluded)

PROPERTY DATA RECORDS

WORD	NAME	DESCRIPTION
1	PHI1-PHI14	Aximuthal Coordinates (degrees) for Stress Recovery.

Note: Repeat words 1 to 14 up to 70 times per data record to specify up to 14 stress recovery coefficients for the TRIAAX and TRAPAX elements.

WORD	NAME	DESCRIPTION
1	T	Thickness
2	MID2	Material Table number for Bending
3	I2IT	Bending Stiffness Parameter
4	MID3	Material for Transverse Shear
5	TST	Transverse Shear Thickness
6	NSM	Non-Structural Mass
7	Z1	Fiber Distance for Stress - 1
8	Z2	Fiber Distance for Stress - 2
9	MID4	Material for Membrane-Bending
10	T1	Membrane Thickness at Node 1
11	T2	Membrane Thickness at Node 2
12	T3	Membrane Thickness at Node 3
13	T4	Membrane Thickness at Node 4
14	MIN	Minimum T Value
15	MAX	Maximum T Value

Note: Repeat words 1 to 15 up to 66 times per data record to specify the properties for TRIA3 and QUAD4 elements.

TABLE 9

MATERIAL DATA RECORDS

WORD	NAME	DESCRIPTION
1	MID	Material Identification Number
2	E	Young's Modulus
3	G	Shear Modulus
4	U	Poisson's Ratio
5	RHO	Density
6	A	Thermal Coefficient
7	TREF	Reference Temperature
8	GE	Damping Coefficient
9	ST	Tension Stress Allowable

TABLE 9 (Concluded)

MATERIAL DATA RECORDS

WORD	NAME	DESCRIPTION
10	SC	Compression Stress Allowable
11	SS	Shear Stress Allowable

Note: Repeat words 1 to 11 for up to 99 times until all MAT1 isotropic materials are stored for the model.

1	MID	Material Identification Number
2	A11	Elastic Modulus Array following the NASTRAN Naming Convention $\sigma = \begin{bmatrix} A11 & A12 & A13 \\ & A22 & A23 \\ & & A33 \end{bmatrix} \varepsilon$
3	A12	
4	A13	
5	A22	
6	A23	
7	A33	
8	RHO	Density
9	A1	Array of Thermal Expansion Coefficient
10	A2	
11	A3	
12	TREF	Reference Temperature
13	GE	Damping Coefficient
14	ST	Tension Stress Allowable
15	SC	Compression Stress Allowable
16	SS	Shear Stress Allowable

Note: Repeat words 1 to 16 for up to 61 times until all MAT2 anisotropic materials are stored for the model.

WORD	NAME	DESCRIPTION
1	MID	Material Identification Number
2	K	Thermal Conductivity
3	CP	Thermal Capacity/Unit Volume

Note: Repeat words 1 to 3 for up to 330 times until all MAT4 isotropic thermal materials are stored for the model.

TABLE 9 (Concluded)

MATERIAL DATA RECORDS

WORD	NAME	DESCRIPTION
1	MID	Material Identification Number
2	KXX	Thermal Conductivity Matrix
3	KXY	
4	KXZ	KXX KXY KXZ
5	KYY	KXY KYY KYZ
6	KYZ	KXZ KYZ KZZ
7	KZZ	
8	CP	Thermal Capacity/Unit Volume

Note: Repeat words 1 to 8 for up to 123 times until all MAT5 anisotropic thermal materials are defined and stored.

WORD	NAME	DESCRIPTION
1	MID	Material Identification Number
2	ET	Transverse Uniaxial Modulus
3	EL	Longitudinal Uniaxial Modulus
4	GL	Shear (LT) Uniaxial Modulus
5	UL	Uniaxial Poisson's Ratio (LT)
6	T	Layer Thickness
7	M	Reference Percent Moisture
8	TE	Reference Temperature
9	AL	Longitudinal Thermal Expansion Coefficient
10	AT	Transverse Thermal Expansion Coefficient
11	BL	Longitudinal Moisture Expansion Coefficient
12	BT	Transverse Moisture Expansion Coefficient
13	DEN	Density of a Layer
14	FTL	Longitudinal Tension Allowable
15	FTT	Transverse Tension Allowable
16	FLT	Shear (LT) Allowable
17	FCL	Longitudinal Compression Allowable
18	FCT	Transverse Compression Allowable
19	IB	Balanced Laminate Clue
20	Blank	Not Used

Note: Repeat words 1 to 20 up to 49 times per data record until the MATC layered composite materials are stored.

4.3.1 POST HEADER RECORD

The POST header record is described in Table 10. The POST header record contains the counters, analysis program name, data types loaded and corresponding master record pointers for the POST data base.

4.3.2 POST MASTER DATA RECORD

The MASTER record is the pointer to the actual data records for a particular data type. Table 11 describes the format of the MASTER records. The MASTER records basically contain sets of condition numbers, identifiers, data record numbers, and counter information for the particular analysis data type for that master record.

4.3.3 POST DATA RECORDS - GRIDS

The POST data records for grid data are described in Table 12. It must be recognized that only those data types supported by a specific analysis program can be stored. For example, NASTRAN can provide eigenvector and element force data while ANALYZE and OPTSTAT will only support the displacement and stress data types.

4.3.4 POST DATA RECORDS - ELEMENTS

The POST data records for element data are described in Table 13. It must be recognized that only those data types supported by a specific analysis program can be stored. For example, NASTRAN can provide eigenvector and element force data while ANALYZE and OPTSTAT will only support the displacement and stress data types. The terminology used for the component names is the same as that used for Tables 6-8 in the "CADS User's Guide," Volume II of this final report.

TABLE 10

POST DATA BASE HEADER RECORD

WORD	NAME	DESCRIPTION
1	NOCOND	Number of Conditions Stored
2	NVREC	Next Valid Record
3	NSTEP	Number of Time Steps Stored
4	NCOND	Condition Number of Next Keys
5	KFORCE	Key to Force Master Record
6	KSTRES	Key to Stress Master Record
7	KDISP	Key to Displacement Master Record
8	KEIGEN	Key to Eigenvector Master Record
9-17	Blank	Not Used; for Expansion Keys
18	MONTH	Month Data was Loaded
19	DAY	Day Data was Loaded
20	YEAR	Year Data was Loaded
21-35	TITLE	60 Character Load Case Title

Note: Repeat words 4 to 35 for up to 61 times until all load cases are stored. This header record is composed of two 990 word physical records.

TABLE 11

POST MASTER RECORD

WORD	NAME	DESCRIPTION
1	NEMAST	Number of Entries in Master Record
2-4	Blank	Not Used
5	NCOND	Condition Number
6	NODE	Largest Node in Node Data Record
7	NREC	Pointer to Node Data Record
8	NGRIDS	Number of Sets of Data in Record

Note: Repeat words 5 to 8 for up to 246 times until all load cases are stored and node data records are pointed to by this master record.

WORD	NAME	DESCRIPTION
1	NEMAST	Number of Entries in Master Record
2-4	Blank	Not Used
5	NCOND	Condition Number
6	ETYPE	Element Type for Data Record
7	NREC	Pointer to Node Analysis Data Record
8	NEL	Number of Sets of Data in Record

Note: Repeat words 5 to 8 for up to 246 times until all load cases are stored and element data records are pointed to by this master record.

TABLE 12

POST NODE DATA RECORDS

WORD	NAME	DESCRIPTION
1	ID	Node Identification Number
2	TX	Translational - X Value
3	TY	Translational - Y Value
4	TZ	Translational - Z Value
5	RX	Rotational - X Value
6	RY	Rotational - Y Value
7	RZ	Rotational - Z Value

Note: Repeat words 1 to 7 for up to 141 times per data record until all of the values are stored for each node. The values may be either displacement or eigenvectors.

TABLE 13

POST ELEMENT DATA RECORDS

WORD	NAME	DESCRIPTION
1	ID	Element Identification Number
2-n	VALUES	Element Component Values

Note: Repeat words 1 to n for each element for each case. The VALUES are the element stress or force components as listed in Tables 6-8 of the Volume II, "User's Guide." They are stored in the same order, for each element type, as listed in those tables.

5.0 SUBROUTINE DESCRIPTIONS

Each of the subroutines or functions developed for the CADS program is described in this section. The DI-3000 graphics routines and system-supplied routines are not included. The routine descriptions include an outline of its purpose and approach, routine inputs and outputs, error messages, external calls, the argument list, a key variable list, and a list of common blocks used in the routine.

The subroutines are listed in alphabetical order which is the order provided in the source code and program listing tape files. The naming convention used for the CADS subroutines attempts to group those routines making up a certain module into a single segment. For example, routines dealing with reading data start with RD; natural generation routines start with NAT; output routines with OUT; plotting routines with PLT, and utility routines with UTL. The characters following the leading characters are generally abbreviations of the command or keyword the routine processes.

The first group of routines includes the Executive Monitor and Block Data routines of CADS. These are followed by the BOX and CHANGE subroutines.

Program: CADS

Algorithm: This is the main controller for the CADS program. It sets initial switches, opens the geometric and post data base files and calls the routines which are the high level controllers for the various CADS functional modules.

Input/Output: Opens terminal message unit 7.
Unit 7 - terminal output for messages
Unit 5 - terminal input
RDCARD - Free read command input

Error Messages: **** MAIN OPTION COMMAND ____ NOT FOUND

External Calls: OUTPUT PLOTGN RDCARD RDCONT START EDITCT

Argument List: None

Important Variables: NBLANK - number of words in BLANK (scratch) common

Common Blocks:

READ	PLOTCN	SCALAR	MAT12	TYPEN	TYPE
PLOTCM	PLOTEL	HEDG	CHAR	SOLIDS	PLTITL
NASTRN	READN	D1TOKD	G03	DIBAUD	MOHEAD
DAVE	PINFLA	PLOTBD	PLOTB2	TEMP	DBREC
TKTRNX	NOHEAD	MATL	ELHEAD	HEADPP	SYSTEM
MATPRO	READCM	NATDSP	BLANK	TRACK1	PERM
PLOT	OPTIND				

Block Data:	MATPRO/TYPEN/	
Algorithm:	This block data initializes the MATPRO and TYPEN labeled common blocks.	
Input/Output:	None	
Error Messages:	None	
External Calls:	None	
Argument List:	None	
Important Variables:	DMAT1	- defines material commands for material types MAT1, MAT2, MAT4, MAT5
	DMAT2	- property definition command array
	NUMEL	- element type numbers for NASTRAN elements
	NUPEL	- number of property values per element
	NUTEL	- NASTRAN numbers for material and property cards
	NUVEL	- number of values/property type
Common Blocks:	MATPRO	
	TYPEN	

Block Data:	CHAR/NASTRN/SOLIDS
Algorithm:	Block data initializes arrays for the NASTRAN elements.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	None

Important Variables:

FORM	- NASTRAN bulk data cards supported
NTERM	- number of items per NASTRAN card
NSTOR	- number of terms to be stored/element type
NNODE	- number of nodes per element
GRIDAX	- grid type data cards
NGTERM	- number of terms per grid type cards
NU	- character array
ITA	- array contains the number of lines defining a higher order element
IT20	- number of line segments for the S020 element
J6A	- array of line endpoints for the TM6 element
J8A	- array of line endpoints for the QM8 element
I4A	- array of line endpoints for the S04 element
I6A	- array of line endpoints for the S06 element
I8A	- array of line endpoints for the S08 element
I20A	- array of line endpoints for the S020 element

Common Blocks: CHAR
NASTRN
SOLIDS

Block Data:	PLOTBD
Algorithm:	Block Data procedure used to initialize the PLOTBD and PLOTB2 common block variables for the DISPLAY module. The valid analysis output type, element pointer, and output component name arrays are initialized.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	None
Important Variables:	OUTNAM - character array with valid analysis output type names
	KEY1 - pointer array into K2 and K3 based on the element type
	K2 - array with number of valid components per data type
	K3 - array with offsets into the component name arrays
	MASKDF - displacement component names
	MASKST - stress component names
	MASKFO - force component names
Common Blocks:	PLOTBD
	PLOTB2

Subroutine:	BOX
Algorithm:	This routine determines which nodes are inside a given geometric shape. It works with the SET module on the BOX command and, through the SPHERE, CYLNDR, and SLAB entry points, processes those commands. For each command the routine cycles through all previously defined nodes and checks their coordinates to determine if they are inside the given geometric shape using standard geometric procedures.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	NO NODES LOCATED WITHIN BOX SET ___ DEFINED BY, XL = __ XU = __ YL = __ YU = __ ZL = __ ZU = __
	VECTOR NODES FOR CYLINDER OPTION FOR SET __ UNDEFINED NODE KEYS WERE ____ ____ ____ ____
	CENTER NODE FOR SPHERE OPTION FOR SET ___ UNDEFINED NODE KEYS WERE ____ ____
	VECTOR NODES FOR SLAB OPTION FOR SET ___ UNDEFINED NODE KEYS WERE ____ ____ ____ ____ ____ ____
External Calls:	IFINDN
Argument List:	XL,XU,YL,YU,ZL,ZU - lower and upper ranges on the box axes
	KOUNT - number of nodes found
	LNOC - node number of nodes found
	NAME - set name of node set
	KPR - error message switch

Argument List (Continued)

CYLNDR ENTRY	N1,N2 - nodes defining the cylinder center line
	R - radius
	KOUNT, LNOC, NAME, KPR - same as BOX
SPHERE ENTRY	N1 - sphere center point
	R - radius
	KOUNT, LNOC, NAME, KPR - same as BOX
SLAB ENTRY	N1,N2,N3 - nodes defining the SLAB plane
	R - distance (thickness) in the positive normal direction
	TT - distance (thickness) in the negative normal direction
	KOUNT, LNOC, NAME, KPR - same as BOX
Important Variables:	Same as argument list
Common Blocks:	BLANK
	PERM

Subroutine:	CHANGE
Algorithm:	This routine takes a series of eight characters and converts them from the free format input to a real number.
Input/Output:	Unit 5 - terminal input Unit 7 - terminal output for messages
Error Messages:	**ERROR** ____ IS AN ILLEGAL REAL NUMBER RE-ENTER:
External Calls:	None
Argument List:	A - array of real numbers returned from CHANGE LHOLD - 8 by NWORD character array of input characters NWORD - number of sets of characters to convert
Important Variables:	Same as argument list.
Common Blocks:	SYSTEM CHAR

The following block of subroutines makes up the EDIT module of CADS. These routines are used to perform the editing functions of CADS thus allowing changes to the GEOMETRY data base. The routines in this block are:

EDITCA
EDITC1
EDITC2
EDITCT
EDITEL
EDITE1
EDITE2
EDITE3
EDITE4
EDITE5
EDITE6
EDITE7
EDITE8
EDITE9
EDITMA
EDITND
EDITPR
EDIT10
EDIT11

Subroutine:	EDITCA
Algorithm:	This routine edits the NASTRAN, ANALYZE, and OPTSTAT executive and case control decks at the terminal. It provides delete, list, replace and add functions for editing. These commands are processed on a line by line basis and the updated information is stored back to the data base.
Input/Output:	Unit 7 - terminal output for messages RDCARD - free read command input IOPAC - packed data base I/O routine NDBUNT - geometry data base output
Error Messages:	** ERROR OPTION _____ NOT FOUND ** ** NO CASE CONTROL CARDS FOR _____ ** INCORRECT LIST REQUEST CARD IGNORED INSUFFICIENT TERMS ENTERED FOR REPLACE/INSERT OPTION
External Calls:	EDITC1 NUMBER EDITC2 RDCARD IOPAC UTLLTG
Argument List:	None
Important Variables:	None
Common Blocks:	READ DBREC NOHEAD MATL READCM

Subroutine:	EDITC1
Algorithm:	This routine deletes and inserts cards in the case control files. It first processes inserts by placing the new cards into the correct location in the file. Next it deletes the user specified case control cards out of the case file.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	IG - switch is used to define delete or insert processing
	NL - the number of case control cards to be inserted
	K2 - the number of entries in LIST
	LIST - array which holds the card numbers for processing
Important Variables:	Same as argument list.
Common Blocks:	READ
	MATL

<u>Subroutine:</u>	EDITC2
<u>Algorithm:</u>	This routine reads in new case control cards for insertion or addition to the existing case control file.
<u>Input/Output:</u>	Unit 7 - terminal output for messages NUNIT - user input unit (usually 5)
<u>Error Messages:</u>	None
<u>External Calls:</u>	None
<u>Argument List:</u>	PROMPT - the prompt string for the user NUNIT - input unit for the user commands HOLD - buffer array to hold commands
<u>Important Variables:</u>	Same as argument list.
<u>Common Blocks:</u>	None

Subroutine: EDITCT

Algorithm: Routine controls the edit routine for changing nodes, elements, materials, and properties. Opens a save file, reads the user commands, sets switches, and calls in the processing routines.

Input/Output:

Unit 5 - terminal input
Unit 7 - terminal output for messages
IOHEAD - data base header record
RDCARD - free read command input

Error Messages:

```
*** ERROR ** OPEN ERROR ON UNIT ___ STATUS ___

*** MODULE: _____ CARD: _____

    EDIT CONTROL OPTION _____ NOT VALID

    EDIT PROCESSOR _____ DOES NOT EXIST

    EDIT PROCESSOR HAS NOT BEEN ENTERED CORRECTLY

*** ERROR ** OPEN ERROR ON UNIT ___ STATUS ___
    FILE WAS NOT SAVED
```

External Calls:

EDITEL	EDITPR	OUTGRD
EDITMA	IOHEAD	RDCARD
EDITND	NUMBER	EDITCA

Argument List: None

Important Variables: None

Common Blocks:

READ	MOHEAD	PERM
BLANK	SYSTEM	
READCM	DBREC	

Subroutine: EDITEL

Algorithm: Routine gets the element connectivity tables for editing. Processes the element edit commands and calls in the routine to act on those commands. Acts as the edit element control routine.

Input/Output: Unit 7 - terminal output for messages

RDCARD - free read command input

Error Messages:

```
** EDIT OPTION _____ NOT FOUND **

** INSUFFICIENT TERMS ENTERED FOR DELETE OPTION **
```

External Calls:

```
EDITE1   EDITE6
EDITE3   LIGRNO
EDITE5   RDCARD
```

Argument List: None

Important Variables: None

Common Blocks:

```
READ     PERM
BLANK    SYSTEM
```

Subroutine:	EDITE1
Algorithm:	This routine lists the element data for the edit element LIST command. It decodes the user commands, retrieves the element group tables and sets switches for groups and elements to be processed. Finally, it lists the requested element data to the terminal.
Input/Output:	IOPAC - geometric data base read/write Unit 7 - terminal output for messages
Error Messages:	*** INCORRECT SYNTAX ELEMENT LIST, CARD IGNORED __ __ __ *** GROUP NUMBER ______ DOES NOT EXIST, CARD IGNORED *** INCORRECT LIST REQUEST, CARD IGNORED *** FOLLOWING ELEMENTS DO NOT EXIST, LIST IGNORED
External Calls:	EDITE2 IOPAC UTLLTG NUMBER ZRAYI
Argument List:	None
Important Variables:	NGR - group numbers for the list LIST - array with the list of elements LICH - array with non-existent elements
Common Blocks:	READ ELHEAD MATL SYSTEM TYPE BLANK NASTRN CHAR DBREC PERM

<u>Subroutine</u>:	EDITE2
<u>Algorithm</u>:	This routine is called by EDITE1 to list the specific element connectivities and element numbers. It simply cycles through the element list outputting information until the list is exhausted.
<u>Input/Output</u>:	Unit 7 - terminal output for messages
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	IC - element connectivity array
	NSS - number of values/element
	NSN - number of nodes/element
	NELMT - number of elements to be listed
	LIST - list of requested elements
	IID - element numbers array
	NEL - maximum number of elements in the group
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine: EDITE3

Algorithm: This routine deletes a group or list of elements in a group. It checks the command syntax, finds the group, and gets the user element list when needed. Then it retrieves the element connectivities and calls EDITE4 to process the actual delete operation. Finally, it writes the element data back to the data base.

Input/Output:

```
Unit 7 - terminal output for messages
IOPAC  - packed array I/O to geometry data base
```

Error Messages:

```
** INCORRECT, DELETE SYNTAX, CARD IGNORED ______

** GROUP NUMBER ___ DOES NOT EXIST, CARD IGNORED

** INCORRECT, DELETE LIST REQUEST, CARD IGNORED

** FOLLOWING ELEMENTS DO NOT EXIST, DELETE IGNORED
```

External Calls:

```
EDITE4   UTLLTG
IOPAC    ZRAYI
NUMBER
```

Argument List: None

Important Variables:

```
NELGRH - group/element pointer array
NGR    - group number
LIST   - list of elements being processed
D      - scratch array with element data
```

Common Blocks:

```
CHAR     BLANK    NASTRN
READ     DBREC    PERM
ELHEAD   MATL     SYSTEM
```

Subroutine: EDITE4

Algorithm: This routine deletes elements from a group and compresses the group of elements. It cycles through the list of elements, zeros out their values, and compresses the group array.

Input/Output: None

Error Messages: None

External Calls: None

Argument List:

IC	- element connectivity array
NSS	- number of connectivity values per element
NELD	- number of elements to be deleted
NELMT	- total number of elements in the group
LIST	- list of requested elements to be deleted
IID	- element ID array
IP	- element property array
NP	- number of property values per element

Important Variables: Same as argument list

Common Blocks: None

Subroutine:	EDITE5
Algorithm:	This routine sets up a list of elements to be changed or added in EDITE7. It decodes user input commands, sets appropriate switches and pointers and gets the element list. Then it calls the EDITE7 routine and finally updates the element connectivities on the geometry data base.
Input/Output:	Unit 7 - terminal output for messages RDCARD - free read input IOPAC - packed array I/O to geometry data base
Error Messages:	** INCORRECT ADD OR CHANGE SYNTAX, CARD IGNORED ** GROUP NUMBER ______ DOES NOT EXIST, CARD IGNORED ** INCORRECT ADD OR CHANGE LIST REQUEST, CARD IGNORED ** NODE NUMBERS DON'T MATCH LIST OF ELEMENTS, CARD IGNORED ** NODE NUMBER ______ DOES NOT EXIST, CARD IGNORED [FOLLOWING ELEMENTS DO NOT EXIST DELETE IGNORED.]
External Calls:	EDITE7 NUMBER UTLLTG IFINDN OUTGRD ZRAYI IOPAC RDCARD
Argument List:	None
Important Variables:	NELGRH - group/element data pointers array LIST - list of elements to be processed NVREC - geometry data base record number for elements KAC - switch for add/change

Common Blocks:			
	CHAR	ELHEAD	MOHEAD
	READ	DBREC	PERM
	BLANK	NASTRN	MATL

Subroutine:	EDITE6
Algorithm:	This routine lists the valid keywords and commands for the element, property, and material editors. Provides a shorthand help function for the edit routines.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	** INCORRECT SYNTAX FOR HELP USE: HELP EL **
	** GROUP NO. ______ DOES NOT EXIST, CARD IGNORED**
	** ELEMENT TYPE ______ NOT SUPPORTED, CARD IGNORED**
External Calls:	NUMBER
Argument List:	None
Important Variables:	NUMEL - element type to be supported
	NUPEL - property type to be supported
	NUTEL - type in the material table
	NUVEL - number of values per property type
	MP - definition array for keywords
	MAP - material keyword array
Common Blocks:	READ ELHEAD TYPEN
	MATPRO NASTRN
	CHAR PERM

Subroutine:	EDITE7
Algorithm:	Routine adds or changes elements for a previously defined group based upon element number or offset values. Cycles through the element list updating node connectivity tables. These are then passed back for storage to the geometry data base.
Input/Output:	None
Error Messages:	None
External Calls:	None

Argument List:

IC	- element connectivity array
NSS	- number of values per element
NSN	- number of nodes per element
NELD	- number of elements to be added or changed
NELMT	- total number of elements in the group
LIST	- list of requested elements to be added or changed
LISTN	- node list for requested elements
IID	- element ID array
KSW	- 1 element numbers are inputted; 2 element offsets are inputted
KAC	- 1 change element connectivity request; 2 add element connectivity request
K	- group number

Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	EDITE8
Algorithm:	This routine is used to decode property values passed from EDITPR. First it checks the keywords against the valid list; decodes the values and stores them in appropriate positions in the data array for the given element. Finally it gets the element ID list from the data base and compares it for matches to the requested element list.
Input/Output:	Unit 7 - terminal output for messages IOPAC - packed geometry data base I/O
Error Messages:	** INCORRECT CHANGE REQUEST, CARD IGNORED ** ** DESCRIPTION ____ NOT VALID FOR PROPERTY TYPE, CARD IGNORED ** FOLLOWING ELEMENTS DO NOT EXIST, DELETE IGNORED
External Calls:	CHANGE UTLLTG IOPAC ZRAYI NUMBER
Argument List:	DMP - array of valid property keywords I1 - number of integers in DMP NIN - locations of the integers in DMP * - alternate return
Important Variables:	Same as argument list
Common Blocks:	READ DBREC PERM MATL TEMP

Subroutine:	EDITE9
Algorithm:	Routine changes material table pointers for a given list of elements. Determines type of element list; generates list of numbers and updates pointer array with new material keys.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	** INCORRECT CHANGE REQUEST, CARD IGNORED **
	** FOLLOWING ELEMENTS DO NOT EXIST, CHANGE IGNORED
	** REQUESTED MAT ID ____ DOES NOT EXIST, CHANGE IGNORED
External Calls:	UTLLTG
	ZRAYI
Argument List:	IMAT - material data array
	LV - number of variables (components) in IMAT
	NMAT - number of materials (rows) in IMAT
	KEY - key pointer into the material table
Important Variables:	Same as argument list
Common Blocks:	READ MATL
	PERM
	TEMP

Subroutine:	EDITMA
Algorithm:	This routine edits the material property table as defined by the user. First, it reads and decodes the input command line. Next, it passes control to the LIST, HELP, CHANGE and ADD processing sections. The routine finishes by updating the geometry data base using IOPAC. It retrieves the appropriate material table based on the requested data types, updates the table and packs it on the geometry data base.
Input/Output:	RDCARD - free read terminal input Unit 7 - terminal output for messages IOPAC - packed geometry data base I/O IODB - performs geometry data base I/O
Error Messages:	** EDIT OPTION ______ NOT FOUND ** ** MATERIAL TABLE _____ DOES NOT EXIST ** INSUFFICIENT TERMS ENTERED FOR CHANGE OPTION ** ** GROUP ______ CANNOT BE LOCATED; USE LI GR TO LIST EXISTING GROUPS
External Calls:	EDITE1 EDIT10 NUMBER EDITE6 IOPAC RDCARD EDITE9 LIGRNO IODB
Argument List:	None
Important Variables:	LIST - array of values to be processed NELGRH - element/group pointer array MID - material table number DMATP - array of material values LV - number of variables per element type NVREC - record being processed from geometry data base

Common Blocks:				
	MATPRO	ELHEAD	TEMP	MATL
	READ	READCM	MOHEAD	TYPEN
	BLANK	DBREC	SYSTEM	PERM

Subroutine:	EDITND
Algorithm:	Routine edits the node values as defined by the user. Will LIST, DELETE, CHANGE, or ADD nodes. Routine transfers to the appropriate command execution array and decodes the appropriate parameters. Makes up a list of nodes to be operated on and then performs the requested operation.
Input/Output:	RDCARD - free read from the terminal Unit 7 - terminal output for messages
Error Messages:	** EDIT OPTION ______ NOT FOUND ** INCORRECT SYNTAX FOR THE LIST GENERATION ** ** NODE NUMBER ______ DOES NOT EXIST ** ** INSUFFICIENT TERMS ENTERED FOR DELETE OPTION ** ** INCORRECT SYNTAX FOR CHANGE COMMAND ** NODE NUMBER ______ DOES NOT EXIST, CHANGE IGNORED

External Calls:

CHANGE	NUMBER	RDCARD	ZRAYI
IFINDN	OUTGRD	RDNPAC	
NATNOD		UTLLTG	

Argument List: None

Important Variables:

NCXYZ	array of node data
LIST	list of nodes to be processed
NONODE	number of nodes
KZ	number of nodes in the LIST array

Common Blocks:	READ	BLANK	DBREC
	NATDSP	NOHEAD	PERM
	MATL	MOHEAD	SYSTEM

Subroutine: EDITPR

Algorithm: Routine is used to edit the property values for user defined elements. Will list valid property values through the HELP command as well as group/elements through LIST. Decodes the user command, transfers to the appropriate command section and processes the command. The CHANGE section retrieves the property block, updates the values as defined by the user, and restores them to the data base.

Input/Output:

RDCARD	- free read terminal input
Unit 7	- terminal output for messages
IOPAC	- packed array I/O to geometry data base

Error Messages:

** EDIT OPTION ______ NOT FOUND

** INSUFFICIENT TERMS ENTERED FOR CHANGE OPTION

** GROUP ______ CANNOT BE LOCATED, USE LI GR TO LIST EXISTING GROUPS

** NO PROPERTY TABLE FOR ELEMENT TYPE ______

External Calls:

EDIT11	IOPAC	RDCARD
EDITE6	LIGRNO	ZRAYB
EDITE8	PRSTR3	NUMBER

Argument List: None

Important Variables:

NELGRH	- array of pointers to element/group data
LOC	- location of data in the property array
LV	- number of values per type

Common Blocks:

TYPE	BLANK	TEMP	MATL	PERM
MATPRO	ELHEAD	DBREC	SYSTEM	TYPEN
READ	READCM	MOHEAD	NASTRN	

Subroutine:	EDIT10
Algorithm:	This routine is used to decode the material property values. It checks the input keyword against the valid names and then places the new value in the appropriate data array.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	DESCRIPTION ___ NOT VALID FOR MATERIAL TYPE, CARD IGNORED
External Calls:	CHANGE
Argument List:	DMP - character array of valid keywords LV - number of valid keywords IMAT - material pointer array NMAT - number of materials
Important Variables:	same as argument list
Common Blocks:	READ MATL PERM TEMP

Subroutine:	EDIT11
Algorithm:	This routine decodes the property values for EDITPR. It checks the element list and gets the valid elements from the user defined list. It then gets the properties for that element list and prints them out to the terminal as a list of element numbers and property values.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	** INCORRECT LIST PROPERTY REQUEST, CARD IGNORED **
	** FOLLOWING ELEMENTS DO NOT EXIST LIST IGNORED
External Calls:	EDITE6 UTLLTG
	IOPAC ZRAYI
Argument List:	D - real array for the property values
	ND - integer array for the property values
	NST - number of components (rows) in the property arrays
	DMP - valid property types for requested element
	I1 - number of property types which have integer values
	NIN - pointer array to property types which are integer
Important Variables:	Same as argument list.
Common Blocks:	READ DBREC
	PERM MATL
	TEMP

The following block of subroutines and functions are general routines used for storing data to the data base, packing data types, and finding grid numbers. The routines in this block are:

FREPCK
FRESTR
GETMAT
GROUPS
IFINDN
IODB
IOHEAD
IOPAC
IOROUT
ISIMEQ
JFINDG
JFINDN
LIGRNO
LINPTS
MAIDCH
MASTR1
MATPCK
MPSTR1

Subroutine:	FREPCK
Algorithm:	This routine packs the node suppressions array ISWS into the word IPCK for packed storage to the data base. The entry FREUCK unpacks the word into an array. If the particular freedom switch in ISWS is set, i.e. ISWS (I) = 1 for I = 1,6, IPCK is multiplied by 10 and the appropriate I value is added to IPCK. The FREUCK entry point reverses the process by dividing by 10.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	ISWS - valued array for suppressions IPCK - packed word of suppressions (output)
FREUCK ENTRY	JSWS - array of suppressions (output) JPCK - packed word of suppressions
Important Variables:	Same as argument list.
Common Blocks:	None

Subroutine:	FRESTR
Algorithm:	This routine stores the grid suppressions for a given node to the required grid array position. Entry FREFRE frees the suppression values previously defined. This routine calls FREUCK and FREPCK to unpack and pack words as needed to save the suppressions information.
Input/Output:	None
Error Messages:	None
External Calls:	FREPCK FREUCK
Argument List:	N5 - node location in the grid array for a given suppression KPCK - packed suppressions ISWS - unpacked suppressions IC - code for the coordinate system type
FREFRE ENTRY	N5,ISWS,IC - same as FRESTR
Important Variables:	Same as argument list.
Common Blocks:	None

Subroutine:	GETMAT
Algorithm:	Routine gets material properties from the geometric data base. It is a lower level routine which uses the number of materials and values per material to determine the location of the material data and obtain the pointers to the correct data base location.
Input/Output:	Calls on IOPAC routine to access the geometric data base.
Error Messages:	None
External Calls:	ZRAYI IOPAC
Argument List:	NSET - storage array for material properties N1 - beginning location in NSET for each material type IA - offset location in the header record per material IROW - number of values per material NOMAT - array of record numbers and offsets per data set I1 - number of input data sets
Important Variables:	Same as argument list.
Common Blocks:	ELHEAD DBREC

<u>Subroutine</u>:	GROUPS
<u>Algorithm</u>:	Routine develops group values as elements are generated or read onto the geometric data base. Values are placed in an in-core matrix and are then used to pack group data for output to the geometry data base. GROUPS calls IOPAC to pack the element group data for the data base.
<u>Input/Output</u>:	Unit 7 - terminal output for messages
<u>Error Messages</u>:	*** THE NUMBER OF GROUPS EXCEEDS INCORE CAPACITY ***
<u>External Calls</u>:	IOPAC
<u>Argument List</u>:	MATRIX - array of information with element connectivities
	N1 - number of elements in the group
	IPROP - property values for the group (new)
	N2 - number of properties
	IOLD - old properties
	N3 - number of previous values
<u>Important Variables</u>:	Same as argument list.
<u>Common Blocks</u>:	DBREC
	ELHEAD
	PERM
	TEMP

Function:	IFINDN
Algorithm:	Function checks to see if a node has been previously defined by using a binary search. If it does exist, its location is returned. It it does not exist, a flag is set and the position at which it would be inserted into the node table is returned.
Input/Output:	None
Error Messages:	None
External Calls:	None
Agrument List:	NODE - node number to search on ILL - location for the new node
Important Variables:	Same as the argument list.
Common Blocks:	BLANK PERM

Subroutine:	IODB
Algorithm:	Routine reads from and writes to the geometric data base on a direct access record basis.
Input/Output:	Direct access READ of a given record from a given unit. Direct access WRITE to a given record on a given unit. Unit 7 - Terminal output for messages
Error Messages:	_____ REQUEST ERROR FROM SUBROUTINE _____
External Calls:	None
Argument List:	IG - switch for read or write: 1 = read; 2 = write A - buffer array for I/O N - number of values in array A IREC - record number of the data NUNIT - unit number of the data SUBNAM - character name of the calling routine for the error message.
Important Variables:	Same as argument list.
Common Blocks:	None

Subroutine:	IOHEAD
Algorithm:	Routine saves or retrieves the header records on the geometry data base. It calls the IODB routine for these functions. It will also perform a straight copy from one unit to another of the entire data base.
Input/Output:	IODB - geometry data base I/O READ - record by record read for the copy function WRITE - record by record write for the copy function
Error Messages:	None
External Calls:	IODB
Argument List:	IG - switch for the command 1 = retrieve; 2 = save; 3 = copy N1 - unit to read from for copy N2 - unit to write to for copy SUBNAM - character name of calling routine
Important Variables:	NVRLA - next record in the GEOM data base
Common Blocks:	NOHEAD PERM ELHEAD MOHEAD DBREC

Subroutine:	IOPAC
Algorithm:	This routine packs an array of information for sending to the data base. It blocks the data to the direct access record size of the data base and calls IODB to perform the actual I/O function.
Input/Output:	None
Error Messages:	None
External Calls:	IODB
Argument List:	ARRAY - data array NWRD - number of words to be stored or retrieved IG - switch to read or write data: 1 = read; 2 = write NDBUNT - data base unit number SUBNAM - name of the calling routine for the error message in IODB
Important Variables:	Same as argument list.
Common Blocks:	DBREC

Subroutine:	IOROUT
Algorithm:	Performs record I/O for temporary files. Reads or writes blocks or buffers of data and stores their locations and pointers in the MAT array for later processing. Uses IODB routine to perform the actual I/O.
Input/Output:	None
Error Messages:	None
External Calls:	IODB
Argument List:	IO - reads data if =1; writes data if =2
	NAM - four character matrix name for data to be stored
	NROW - number of rows in the matrix
	NCOL - number of columns in the matrix
	IDATE - calender date
	MATRIX - matrix of information
Important Variables:	Same as argument
Common Blocks:	TRACK1

<u>Function</u>:	ISIMEQ
<u>Algorithm</u>:	Solves simultaneous linear equations using the determinant and pivot method.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	DSM - size of the coefficient matrix
	NE - actual number of equations for this call
	NC - number of columns in the constant matrix
	A - coefficient matrix
	B - constant matrix
	DET - input: scale factor, output: factor times the determinant value of the coefficient matrix
	C - temporary storage matrix
<u>Important Variables</u>:	Same as argument list.
<u>Common Blocks</u>:	None

Function:	JFINDG
Algorithm:	Similar to function IFINDN except that it searches a table passed to it for the requested node. JFINDG uses a binary search procedure to determine a node's position in the given table. If it is not found, the location at which the node should be inserted is returned.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	NODE - node number to be found NUM - number of nodes in the input table NODES - node table with NUM nodes each with N values N - number of values per node in the table M - position in node values at which to look for NODE
Important Variables:	Same as argument list
Common Blocks:	None

<u>Function</u>:	JFINDN
<u>Algorithm</u>:	Searches a one-dimensional input array for the location of a given integer value. Uses a binary search to determine the position of a given value in the array.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	NODE - given integer value to be searched for NUM - number of entries in the NODES array NODES - array to be searched for NODE
<u>Important Variables</u>:	Same as argument list.
<u>Common Blocks</u>:	PERM

Subroutine:	LIGRNO
Algorithm:	This routine controls the listing of groups or nodes in the SET, PRINT, and NATURAL modules. First, it decodes the input command line to determine the list of nodes or groups to be retrieved for printing. Then it cycles through the node or group tables and lists out the appropriate information.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	** CONTROL OPTION ____ FOR LIST GENERATOR IS INCORRECT ** INCORRECT SYNTAX FOR THE LIST GENERATION **
External Calls:	IFINDN PAGMOD UTLLTG
Argument List:	NVAR - number of variables on the command line LIST - list of nodes or groups to be printed
Important Variables:	Same as argument list.
Common Blocks:	READ ELHEAD PERM TYPE BLANK SYSTEM CHAR NASTRN

<u>Subroutine</u>:	LINPTS
<u>Algorithm</u>:	Generates a list of nodes and coordinates along a line in space. Determines the number of points to generate and then uses NATSTR to store the points based upon the delta values used to move along the line. If the ALIGNMENT parameter was used on the NODE command, this routine determines the distance to move along the given line to generate the next node. The routine then cycles until the node list to be defined is exhausted.
<u>Input/Output</u>:	Unit 7 - terminal output for messages
<u>Error Messages</u>:	**** MODULE: _____ CARD: _____ LINEAR SPACING USED FOR NODES ___ ___ RATHER THAN PERCENTAGE FUNCTION **** MODULE: _____ CARD: _____ DELTA INTERVAL BAD BETWEEN NODES ____ ____
<u>External Calls</u>:	NATSTR PLTR01
<u>Argument List</u>:	None
<u>Important Variables</u>:	None
<u>Common Blocks</u>:	BLANK NATDSP MATL READCM TEMP

Subroutine:	MAIDCH
Algorithm:	Routine is used to change duplicate material numbers if they occur, when multiple data sets are read in to form a single model. This routine uses a step-by-step procedure to check each currently stored material number against the new ones for duplicates. If duplicates are found the second is incremented by a value greater than the last one stored and processing continues.
Input/Output:	None
Error Messages:	None
External Calls:	IOPAC
Argument List:	None
Important Variables:	None
Common Blocks:	ELHEAD PERM MAT12 BLANK DBREC

Subroutine:	MASTR1
Algorithm:	Stores material table number for a list of elements and stores material values for the elements. Routine loads the IOLD array based upon the material and element counts and a list of input values. Entry MASTR2 loads the property values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	IMAT - material numbers
	IOLD - storage array for the material numbers
	LIST - list of element positions at which to load the values
	K3 - number of elements in LIST
MASTR2 ENTRY	MAT - material values
	IOLD,LIST,K3 - same as MASTR1
	KS - start position to be used in the IOLD list
Important Variables:	Same as argument list.
Common Blocks:	None

Subroutine:	MATPCK
Algorithm:	Routine controls the material property table storage to the geometry data base. It reads into core the material data from a temporary file and then calls in RDNMAT to sort and store the tables.
Input/Output:	ND2 - scratch file read to get material tables
	Unit 7 - terminal output for messages
Error Messages:	*** INSUFFICIENT MATERIAL WORKING ROOM (MAT1)
External Calls:	RDNMAT
Argument List:	None
Important Variables:	None
Common Blocks:	BLANK TEMP NASTRN MOHEAD
	PERM READN DBREC TRACK1

Subroutine:	MPSTR1
Algorithm:	Routine decodes and stores the element geometric property values for the DIRECT property generator. The CHANGE and NUMBER functions are used to convert parameter variables to values which are stored as properties. The values are decoded based upon the allowable size parameters for a specific element type.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** MODULE: ____ CARD: ____ DESCRIPTION ____ NOT VALID FOR MATERIAL OR PROPERTY ID. ______
External Calls:	CHANGE ZRAYB NUMBER RDNOUT
Argument List:	MP - element type number to define the possible number of values DMP - array of character keywords for the given element type I1 - number of values in the NIN array NIN - array of switches identifying integer valued parameters for the given element properties
Important Variables:	Same as argument list.
Common Blocks:	READ TEMP NASTRN READCM BLANK TYPEN

The following block of subroutines and functions makes up the NATURAL generation processor of CADS. These routines provide the node, element, constraint, load, and attribute definition generation functions for CADS. The routines in this block are:

NATANS	NATLOA
NATAN1	NATLO1
NATAN2	NATNCT
NATAN3	NATNIT
NATAN4	NATNOD
NATAN5	NATPRP
NATDIR	NATSHP
NATDOP	NATSTR
NATDO1	NATTMS
NATELM	NATTRF
NATFRE	NUMBER

Subroutine:	NATANS
Algorithm:	Routine is used to define the composite layer data for user specified elements. It starts by initializing counters and begins decoding inputs for the routine. The BASIS command sets the zero degree material direction; CID is decoded to provide the uniaxial properties; and finally, the PLIES and GROUP commands are processed to give the laminate layups on the individual elements.
Input/Output:	IODB - direct access read of material data from the GEOM data base RDCAR1 - free read input of user commands Unit 7 - terminal output for messages
Error Messages:	*** CONTROL OPTION _____ FOR COMPOSITE PROCESSOR IS NOT CORRECT, CARD IGNORED *** PLY KEYWORD _____ IS NOT VALID, RECORD IGNORED *** CID _____ NOT IN MATERIAL TABLE, RECORD IGNORED

External Calls:

CHANGE	NATAN2	NATAN5	RDCAR1	ZRAYB
IODB	NATAN3	NUMBER	UTLBAS	
NATAN1	NATAN4	OUTGRD	UTLLTG	

Argument List: None

Important Variables:

OPTION - array with valid command options

NMID - number of the composite material

Common Blocks:

READ	DBREC	MOHEAD	ELHEAD	
BLANK	MATL	PERM	SYSTEM	TEMP

Subroutine:	NATAN1
Algorithm:	This routine actually decodes the uniaxial composite material properties and places them in the appropriate location in the composite material data array.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** CONTROL OPTION ____ FOR COMPOSITE MATERIALS IS NOT CORRECT, CARD IGNORED
External Calls:	CHANGE NUMBER
Argument List:	NMID - number of the material in the composite table
Important Variables:	MID - composite uniaxial data table for integer values CMID - real array for composite values; equivalenced to MID
Common Blocks:	READ MATL PERM

Subroutine:	NATAN2
Algorithm:	This routine is used to break up the scratch core area for the working arrays needed for the composite material processing. Using the number of elements, nodes, and property values the working storage requirement is determined.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** NATAN2 NET ____ GROUP ____ CANNOT BE LOCATED *** INSUFFICIENT WORKING AREA FOR COMPOSITE PROCESSING INCREASE NBLANK AND DIMENSION D IN MAIN BY ____
External Calls:	ZRAYB
Argument List:	None
Important Variables:	NELMT - number of elements in the group NSP - number of property values for the element type NONODE - number of nodes in the model NBLANK - maximum blank working storage area N3 - number of words required = NONODE*5+22+NELMT*(30+NSP)
Common Blocks:	BLANK MOHEAD TEMP DBREC ELHEAD PERM NASTRN

Subroutine:	NATAN3
Algorithm:	This routine is used to incorporate the beta angle for each element. This angle is formed by the basis vector and the element x-axis. It is computed by determining the difference between the basis angle and the element x-axis from the global or base X-axis.
Input/Output:	IOPAC - packs the beta angle table for output to the data base
Error Messages:	None
External Calls:	IFINDN IOPAC
Argument List:	IBUFF - buffer array for the element node connectivities BUFF - buffer array for the beta angle element value NROW - number of rows in IBUFF and BUFF R1 - basis vector angle LIST - list of composite elements for beta angle generation
Important Variables:	Same as argument list
Common Blocks:	BLANK MOHEAD DBREC ELHEAD TEMP

Subroutine:	NATAN4
Algorithm:	This routine stores the ply orientations and numbers of plies for the defined elements. It uses a list of elements to be processed and the NNPLY array of ply values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	NNPLY - array of ply values LIST - list of elements for processing N - number of elements in LIST
Important Variables:	Same as argument list
Common Blocks:	TEMP

Subroutine:	NATAN5
Algorithm:	This routine computes the composite element thicknesses and packs the layer property information for storage to the geometry data base. First, it reads the property values, beta angles, and ply values. These arrays are then packed into storage records for output to the data base. Finally the element pointer arrays are updated to point to the new composite values.
Input/Output:	IOPAC - packed data I/O for GEOM data base
Error Messages:	None
External Calls:	IOPAC ZRAYB
Argument List:	NNPLY - array with the ply layer data
	IOLD - array with the element pointer data
	PROP - array with the composite property information
	NROW - number of rows in PROP
	LIST - list of composite elements
	LC - switch array for the composite elements
Important Variables:	Same as argument list
Common Blocks:	ELHEAD MOHEAD MATL
	DBREC TEMP

Subroutine: NATDIR

Algorithm: Routine is the main DIRECT property generation processor. It decodes the command lines; sets up stacks of material and property tables; and processes the various DIRECT generation commands.

Input/Output:

Unit 7 - terminal output for messages

Unit 2 - scratch data base unit

RDCAR1 - free read command lines.

IOPAC - packed data I/O for GEOM data base

Error Messages:

```
*** MODULE_____ CARD_____
    CONTROL OPTION _____ FOR DIRECT PROPERTY INPUT
    IS NOT CORRECT

NET _____ GROUP _____ CANNOT BE LOCATED

NET _____ GROUP _____ KEYWORD _____ IS NOT VALID,
DEFAULT USED

_____ D _____ NOT LOCATED FOR NET _____ GROUP _____

INVALID CHANGE SYNTAX ENCOUNTERED, CHANGES IGNORED

SIZE KEYWORD NOT LOCATED FOR PGEN CARD IN NET ____ GROUP
____

NUMBER OF ELID'S DO NOT EQUAL NUMBER OF VALUES ON PGEN
CARD FOR NET _____ GROUP _____
```

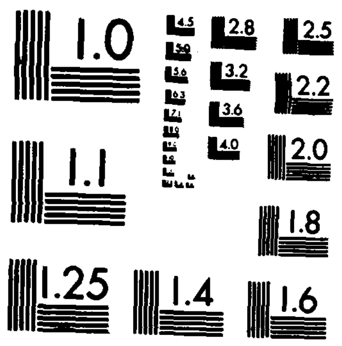
External Calls:

CHANGE	MATPCK	PRSTR1	MASTR1
IOPAC	MPSTR1	PRSTR2	RDCAR1
MASTR2	NUMBER	UTLLTG	

Argument List	None				
Important Variables:	None				
Common Blocks:	BLANK	ELHEAD	TYPEN	PERM	READCM
	MATPRO	DBREC	MATL	READ	TEMP
	MOHEAD	NASTRN	SYSTEM	READN	

Subroutine:	NATDOP
Algorithm:	Routine closes DI-3000 and resets the window and viewport before re-opening DI-3000 for additional graphics output.
Input/Output:	None
Error Messages:	None
External Calls:	JCLOSE JVPORT JFRAME JWINDO JOPEN
Argument List:	None
Important Variables:	None
Common Blocks:	D1TOKD

Subroutine:	NATD01
Algorithm:	Routine resets the window and viewport before opening DI-3000 for graphics output. Routine is used in the display of element generator functions.
Input/Output:	None
Error Messages:	None
External Calls:	JWINDO JVPORT JOPEN
Argument List:	None
Important Variables:	None
Common Blocks:	D1TOKD



MICROCOPY RESOLUTION TEST CHART
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Subroutine: NATELM

Algorithm: This routine generates elements based upon the user requests. The routine first decodes the support commands (i.e. ROTATE, LIST, etc.) and then decodes the actual element definition command. It establishes the element type and connectivity list and loads the data in the group currently being processed.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

```
** ROTATE KEYWORD ________ IS NOT VALID RE-ENTER **

*** GROUP NUMBER MUST BE SUPPLIED BEFORE ELEMENT INPUT

*** MODULE: _____ CARD: _____
    ELEMENT TYPE ____ NOT SUPPORTED FOR NATURAL MODE
     INPUT

    ALL ELEMENTS OF A GROUP MUST BE THE SAME TYPE
    INCORRECT NUMBER OF NODES SUPPLIED FOR ELEMENT
     TYPE _____

    INCORRECT NUMBER OF INCREMENTS SUPPLIED FOR ELEMENT
     TYPE _____

    INCORRECT NUMBER OF CLOSING ELEMENT NODES SUPPLIED
     FOR ELEMENT TYPE _____

    FOR ZERO NODE INCREMENT VALUES, STARTING AND ENDING
     NODES MUST BE THE SAME

    ALL NODE DELTA INCREMENTS BETWEEN START TO FINISH
     MUST BE THE SAME

    REPEAT CARD DOES NOT MATCH PREVIOUS NODE CARD FOR
     NUMBER OF VARIABLES REQUIRED
```

Error Message:
(Continued)

GROUP _____ HAS INVALID DUPE KEYWORD

INVALID LIST GENERATED FOR SUB-ELEMENT GENERATION

GROUP _____ DUPE COMMAND HAS NOT REFERENCED A PREVIOUSLY STORED GROUP

External Calls:

CHANGE	JCLOSE	NATD01	PLTGNO	PLTRVH	ZRAYB
GROUPS	JMOVE	NATDOP	PLTNAT	RDCAR1	ZRAYI
IOPAC	LIGRNO	NUMBER	PLTPLS	UTLLTG	JFRAME

Argument List:

H	- horizontal position of the node on the screen
V	- vertical position of the node on the screen
Z	- z position of the node
IBUFF	- buffer array for scratch storage
MATRIX	- storage array for element connectivity
IOLD	- array to track the element group numbers

Important Variables: Same as argument list.

Common Blocks:

READ	MOHEAD	NASTRN
TYPEN	BLANK	TEMP
TYPE	READCM	PERM
ELHEAD	SYSTEM	MATL
PLOTCM	DBREC	NATDSP

Subroutine: NATFRE

Algorithm: Routine controls the specification of node degrees of freedom in the NATURAL generation module. It begins by decoding the command line and then gets the nodes to be processed and their constraints. Finally, it calls the FRESTR routine to actually store the constraints in the data base.

Input/Output:

RDCAR1 - performs free read command line input

Unit 7 - terminal output for messages

Error Messages:

*** FREEDOM CONTROL OPTION ____ NOT CORRECT, CARD IGNORED

*** INVALID KEYWORD _____ ENCOUNTERED, EITHER MISSING OR MISSPELLED

*** THE ALL KEYWORD WAS ASSUMED

*** NODE SET _____ IS NOT ON DATA BASE

*** NO NODES ENCOUNTERED WITHIN INPUT LIST

*** NO DISPLACEMENT COMPONENTS WERE INDICATED FOR OPERATIONS

External Calls:

FREFRE	IFINDN	UTLLTG	RDCAR1
FREPCK	IOROUT	FRESTR	

Argument List: None

Important Variables: None

Common Blocks:

BLANK

SYSTEM

PERM

Subroutine:	NATLOA
Algorithm:	Routine is used to read in node point external load data as translational forces or rotational moments. Routine decodes user options, branches to set the appropriate factor, case, and other switches, and obtains the list of affected nodes. Finally, it places the load factors on the nodes and calls in a packing array.
Input/Ouput:	RDCAR1 - free read input for user commands Unit 7 - terminal output for messages
Error Messages:	*** CONTROL OPTION ____ FOR LOAD PROCESSOR IS NOT CORRECT, CARD IGNORED *** NODE KEYWORD ____ IS NOT VALID, RECORD IGNORED *** CARD ____ IS NOT VALID, RECORD IGNORED
External Calls:	CHANGE RDCAR1 NUMBER NATL01 UTLLTG ZRAYB
Argument List:	LOAD - array to hold the applied loads values
Important Variables:	FACTL - force factor FACTM - moment factor NCA - case number
Common Blocks:	READ DBREC PERM MATL ELHEAD SYSTEM NOHEAD MOHEAD

Subroutine:	NATL01
Algorithm:	Routine takes the applied load matrices and packs them for storage on the GEOM data base. Routine stores the key pointer, case number, and number of loads.
Input/Output:	IOPAC - pack routine for loading the GEOM data base
Error Message	None
External Calls:	IOPAC
Argument List:	LOMO - input loads or moment array LL - key to load or moment position
Important Variables:	Same as argument list
Common Blocks:	NOHEAD PERM MOHEAD DBREC

Subroutine:	NATNCT
Algorithm:	This routine controls the node generation functions. It decodes a command line, sets appropriate switches, and finally calls in the correct routine for processing the command.
Input/Output:	RDCAR1 - free read command input Unit 7 - terminal output for messages
Error Messages:	**** NODES CONTROL OPERAND _____ NOT CORRECT, CARD IGNORED **** NODES PROCESSOR MODULE _____ NOT SUPPORTED **** NODE PROCESSOR MODULE NAME HAS NOT BEEN ENTERED
External Calls:	NATFRE NATTRF RDNPAC NATLOA NATNOD OUTGRD NATSHP RDCAR1
Argument List:	None
Important Variables:	None
Common Blocks:	READ MOHEAD NATDSP SYSTEM BLANK NOHEAD PERM DBREC

Subroutine:	NATNIT
Algorithm:	Routine interprets the node string command input. Checks to see if a start node exists; interprets coordinate locations; and cycles through the input list storing newly generated nodes.
Input/Output:	Unit 7 - terminal output for messages
Error Message:	*** MODULE:_____ CARD:_____ NODE____ DOES NOT PREVIOUSLY EXIST
External Calls:	IFINDN NATSTR PLTR01
Argument List:	None
Important Variables:	None
Common Blocks:	BLANK PERM TEMP READCM NATDSP MATL

Subroutine:	NATNOD
Algorithm:	Generates the node coordinate locations in the DIRECT submodule of the NATURAL generation module. Interprets the node commands and sets the switches as needed. Next, the routine sets up the node and coordinates from the command line for the generation of the actual list of nodes. The REPEAT command is then processed and the nodes are stored to the data base.
Input/Output:	RDCAR1 - free read command input. Unit 7 - terminal output for messages
Error Messages:	*** MODULE: _________ CARD: _________ NODE CONTROL OPTION _____ NOT CORRECT CARD IGNORED *** ______ IS A BAD KEYWORD RE-ENTER *** COORDINATE DIRECTION IS NOT CORRECT INVALID NODE GENERATION KEYWORD REPEAT CARD DOES NOT MATCH PREVIOUS NODE CARD FOR NUMBER OF VARIABLES REQUIRED CANNOT FIND NODE ______ FOR REPEAT LENGTH MUST EQUAL SUM OF INDIVIDUAL TERMS EQUATE LIST HAS INCORRECT NUMBER OF TERMS NODE ______ DOES NOT PREVIOUSLY EXIST, NODE _____ NOT ASSIGNED NODE ______ EXISTS AND CANNOT BE EQUATED

External Calls:	CHANGE	JMOVE	NATD01	NATSTR	RDCAR1
	IFINDN	LIGRNO	NATDOP	NUMBER	JFRAME
	JCLOSE	LINPTS	NATNIT	PLTR01	

Argument List: None

Important Variables:

INTP	stores node or coordinate value from the command line
KIND	keeps the type of value for the equivalent command line available

Common Blocks:	READ	READCM	SYSTEM	NATDSP
	CHAR	PLOTCM	PERM	
	BLANK	TEMP	MATL	

Subroutine:	NATPRP
Algorithm:	Routine decodes the property generation commands to determine which generator to call in. Calls in the DIRECT or COMPOSITE generator.
Input/Output:	RDCAR1 - free read command input Unit 7 - terminal output for messages
Error Messages:	**** PROPERTY CONTROL OPERAND ____ NOT CORRECT CARD IGNORED **** PROPERTY PROCESSOR ____ IS NOT SUPPORTED **** PROPERTY PROCESSOR NAME HAS NOT BEEN ENTERED
External Calls:	NATANS NATDIR RDCAR1
Argument List:	None
Important Variables:	None
Common Blocks:	BLANK PERM SYSTEM

Subroutine: NATSHP

Algorithm: Generates nodes along a section of a circle, ellipse, or parabola. First initializes the variables, next decodes the command input, and finally processes the command. Nodes are generated and stored for the current command based upon the type of curve being used to define the shape.

Input/Output: RDCAR1 - free read command input
Unit 7 - terminal output for messages

Error Messages:

*** SHAPES CONTROL OPERAND _______ NOT CORRECT, CARD IGNORED

*** SHAPES KEYWORD ______ IS NOT CORRECT

*** NO NODES ENCOUNTERED WITHIN THE INPUT LIST

*** INCORRECT SYNTAX FOR THE SHAPE OPERATION

*** INCORRECT LENGTH SPECIFIED FOR SHAPE, LENGTH MUST BE LESS THAN _____ DEGREES

*** INCORRECT NUMBER OF INTERVALS SPECIFIED FOR NODE SPACING

*** LENGTH MUST BE EQUAL TO SUMMATION OF TERMS

*** _______ IS A BAD KEYWORD RE-ENTER ***

External Calls:

CHANGE	LIGRNO	NUMBER	JFRAME
IFINDN	NATDO1	PLTRO1	
JCLOSE	NATDOP	RDCAR1	
JMOVE	NATSTR	UTLLTG	

Argument List:	None			
Important Variables:	VALUES - array of degree interval values for the new nodes			
	CL - array of coordinates for the new node			
Common Blocks:	TEMP	SYSTEM	PERM	
	READ	PLOTCM	BLANK	NATDSP

Subroutine:	NATSTR
Algorithm:	Routine stores the actual node and coordinates to the permanent array and data base. Will generate the mirror and center nodes if required.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** NODE _____ _____ _____ _____ ALREADY EXISTS, WAS REPLACED
External Calls	IFINDN
Argument List:	NEWPNT - array with the new node and its coordinates ISLOT - position in the permanent array for the node
Important Variables:	Same as argument list
Common Blocks:	BLANK PERM TEMP

<u>Subroutine</u>:	NATTMS
<u>Algorithm</u>:	Routine resolves the coordinate system transformation matrices for rectangular, cylindrical, and spherical reference systems. Determines the transformation matrix based on the given input vectors for the specified reference system.
<u>Input/Output</u>:	Unit 7 - terminal output for messages
<u>Error Messages</u>:	*** COORDINATE SYSTEM _______ WAS DUPLICATED *** COORDINATE SYSTEM _______ APPEARS COLINEAR
<u>External Calls</u>:	UTLCRS
<u>Argument List</u>:	ISYS - coordinate system number NSYS - number of different systems TA - three value vector defining point A TB - three value vector defining point B TC - three value vector defining point C
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	PERM MATL

Subroutine:	NATTRF
Algorithm:	Routine transforms a set of nodes from the currently defined coordinates to a new user specified system. Routine decodes the transformation commands, calculates the required transformation matrix and then processes the defined set of nodes for their transformation.
Input/Output:	RDCAR1 - free read command input Unit 7 - terminal output for messages
Error Messages:	*** ERROR IN TRANSFORMATION ROUTINE, SECTION: _____ *** COMMAND WORD BEING ANALYZED WAS: ______ *** COMMAND IGNORED
External Calls:	CHANGE ISIMEQ UTLLTG RDCAR1 IFINDN NUMBER IOROUT
Argument List:	None
Important Variables:	VALUE - array of decoded input values TRANS - transformation array
Common Blocks:	MATL PERM BLANK SYSTEM

Function:	NUMBER
Algorithm:	Function converts input characters to internal integer numbers.
Input/Output:	Unit 5 - terminal input of new variable after error message Unit 7 - terminal output for messages
Error Messages:	*** _______ IS AN ILLEGAL INTEGER NUMBER RE-ENTER
External Calls:	None
Argument List:	LHOLD - character array input to be converted
Important Variables:	Same as argument list
Common Blocks:	SYSTEM CHAR

The following block of subroutines makes up the OUTPUT module and processors of CADS. These routines provide the output translators from the GEOMETRY data base to the ANALYZE, NASTRAN, or OPTSTAT formats. The routines in this block are:

OUTANA	OUTNCD
OUTAN1	OUTNHX
OUTAOG	OUTNLM
OUTAOL	OUTNQT
OUTBAR	OUTNRO
OUTCAL	OUTNR2
OUTCEL	OUTNT6
OUTCQA	OUTNWT
OUTCQT	OUTOPT
OUTGRD	OUTOP1
OUTNAL	OUTOP2
OUTNAT	OUTPPK
OUTNAX	OUTPUT
OUTNB2	PAGMOD

Subroutine:	OUTANA
Algorithm:	Routine is used to output the model information in the ANALYZE program format. Routine first retrieves the material, connectivity, and coordinate information. The control words, material properties, and connectivity are then output. Finally the grids and applied loading data are output.
Input/Output:	KUNIT - output file unit for ANALYZE data IODB - direct access routine for data base I/O
Error Messages:	None
External Calls:	IODB OUTAOL OUTAOG OUTAN1 ZRAYB
Argument List:	None
Important Variables:	MAT1 - material table array PAT1 - element sizes array IBND - boundary condition array XYZ - coordinate position array MEMBS - number of elements JOINTS - number of nodes
Common Blocks:	NOHEAD MOHEAD BLANK ELHEAD PERM DBREC MATL

Subroutine:	OUTAN1
Algorithm:	Routine retrieves the element connectivity and material data for output in the ANALYZE format. It cycles through the pointer table and retrieves the connectivity for each element type after having retrieved the entire material table.
Input/Output:	IODB - performs I/O directly to GEOM data base IOPAC - data pack/unpack routine for data base I/O Unit 7 - terminal output for messages
Error Messages:	*** ERROR *** TOO MANY ANALYZE ELEMENTS; USED= _____ LIMIT FOR ANALYZE IS 295
External Calls:	IOPAC JFINDG IODB OUTOP2
Argument List:	MEMBS - number of elements in the model
Important Variables:	NNODES - array with the number of nodes per element NELMT - number of elements per type MA,MB,MC,MD - connectivity arrays for the elements
Common Blocks:	NOHEAD MOHEAD BLANK MATL ELHEAD PERM DBREC

Subroutine:	OUTAOG
Algorithm:	Subroutine outputs the grid point coordinate information for ANALYZE and OPTSTAT. This routine retrieves the coordinate and suppression information from the data base and then unpacks the data into the coordinate and boundary arrays. These are returned to OUTANA or OUTOPT for output in the correct format.
Input/Output:	IODB - data base I/O routine
Error Messages:	None
External Calls:	IODB SORTQ
Argument List:	XYZ - coordinate value array IB - boundary condition array MM - switch for 2-D or 3-D problem JOINTS - number of nodes IBND - counter for the number of boundary points
Important Variables:	Same as argument list
Common Blocks:	NOHEAD PERM MOHEAD DBREC

Subroutine:	OUTAOL
Algorithm:	Subroutine is used to retrieve and pack the applied load data for ANALYZE and OPTSTAT. Gets the pointers to the loads and retrieves them from the data base. This data is then packed by node, component, and case for output in OUTANA or OUTOPT.
Input/Output:	IODB - performs I/O directly to GEOM data base
	IOPAC - data base pack/unpack routine for I/O
Error Messages:	None
External Calls:	IOPAC IODB
	ZRAYB JFINDG
Argument List:	NJLODS - array with the number of values per load case
	LOADS - number of load cases
Important Variables:	JM - array with nodes loaded for each value and load case
	IM - array of load component directions for each JM node
	TFR - array of actual load values for JM nodes
Common Blocks:	MOHEAD PERM DBREC
	NOHEAD BLANK MATL

Subroutine:	OUTBAR
Algorithm:	Routine outputs the bending beam property data in NASTRAN format as a PBAR card. It determines the number of values to be output and then uses the correct format to output the required PBAR card along with any necessary continuation cards.
Input/Output:	KUNIT - writes bulk data cards to a specified output unit
Error Messages:	None
External Calls:	None
Argument List:	ICON - counter for the number of continuation cards output
	JBAR - integer array of PBAR values
	BAR - real array of PBAR values
	KB - counter for the number of PBAR cards required
Important Variables:	Same as argument list
Common Blocks:	PERM

Subroutine:	OUTCAL
Algorithm:	Routine outputs layered composite elements in NASTRAN format. Gets the layer data; sets up the element format; and then outputs the connectivity, property, and material cards.
Input/Output:	IOPAC - packed array I/O to geometry data base KUNIT - writes bulk data cards to the given output unit
Error Messages:	None
External Calls:	IOPAC OUTCQA
Argument List:	IT - location of the group in the header array IBUFF - integer connectivity array BUFF - real connectivity array (equivalenced IBUFF) N1 - number of values per element in the connectivity array NPROP - integer property array PROP - real property array (equivalenced IPROP) N2 - number of values per element in the property array ID - array containing element id, number of orientation angles, composite material table key and layer offset information
Important Variables:	Same as argument list
Common Blocks:	CHAR MATL PERM ELHEAD TEMP DBREC NASTRN

Subroutine:	OUTCEL
Algorithm:	Routine retrieves data for layered composite elements for output in NASTRAN format. Gets the size and pointer values for each data block (element, property, material) and calls IOPAC to retrieve the appropriate data.
Input/Output:	IOPAC - packed array I/O to geometry data base
Error Messages:	None
External Calls:	IOPAC OUTCAL OUTCQT
Argument List:	None
Important Variables:	NELGRH - group/element pointer array NGROUP - number of groups D - scratch array for element data N - position in D of the element data N1 - position in D of the property data N2 - position in D of the material information
Common Blocks:	BLANK MATL PERM ELHEAD NASTRN DBREC TEMP

Subroutine:	OUTCQA
Algorithm:	Routine computes the element thickness and material matrix (Q) for a single layer orientation. Passes the information back for output as NASTRAN property and MAT2 bulk data cards. Uses standard lamination theory to generate the material matrix.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	** MATERIAL ID ______ DOES NOT EXIST IN COMPOSITE MATERIAL TABLE FOR ELEMENT NO. ______
External Calls:	JFINDG ZRAYB
Argument List:	A - output Q matrix, density, and allowable stresses T2 - output thickness of the element ID - input array containing the element id, material id, layer offsets, and material key * - alternate return
Important Variables:	Same as argument list
Common Blocks:	MATL TEMP

<u>Subroutine</u>:	OUTCQT
<u>Algorithm</u>:	Routine outputs layer composite data for the CQUAD4 and CTRIA3 elements. First it retrieves the layer data and ply information for the elements. Routine then calls OUTCQA to get the material matrix and cycles through the elements outputting the appropriate connectivity, property, and material cards.
<u>Input/Output</u>:	KUNIT - NASTRAN bulk data output unit IOPAC - packed array I/O to geometry data base
<u>Error Messages</u>:	None
<u>External Calls</u>:	IOPAC OUTCQA
<u>Argument List</u>:	IT - location of the group in the header array IBUFF - integer connectivity array BUFF - real connectivity array N1 - number of values per element in IBUFF NPROP - integer property array PROP - real property array N2 - number of values per element in IPROP ID - array containing element id, material id, layer offset, and material key
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	CHAR MATL PERM ELHEAD TEMP DBREC NASTRN

Subroutine:	OUTGRD
Algorithm:	Outputs the model coordinate information as NASTRAN GRID bulk data cards. First, it reads in the grid data records from the data base; codes the information into the correct format, and finally prints out the correct GRID or RINGAX card.
Input/Output:	KUNIT - outputs card image file for NASTRAN bulk data
Error Messages:	None
External Calls:	IODB OUTNCD ZRAYB
Argument List:	IG - switch for the type of output CXYZ - real array of node values NCXYZ - integer array of node values
Important Variables:	Same as argument list
Common Blocks:	BLANK PERM NOHEAD DBREC SYSTEM MATL

Subroutine:	OUTNAL
Algorithm:	Routine outputs the standard three and four corner elements, sets the switches, decodes the element type, sets the correct format, and writes the connectivity and property cards.
Input/Output:	KUNIT - output file for NASTRAN data
Error Messages:	None
External Calls:	OUTPPK

Argument List:

IT	- group number for the elements to be output
IBUFF	- integer number array for the element data
BUFF	- real number array for the element data
N1	- number of rows in the IBUFF array
NPROP	- integer number array for the properties
PROP	- real number array for the properties
N2	- number of rows in the PROP and PMAT arrays
IOLD	- element number position array
N3	- number of rows in the IOLD array
NPMAT	- integer number array for materials
PMAT	- real number array for materials

Important Variables: Same as argument list

Common Blocks:

CHAR	ELHEAD	NASTRN
TEMP	PERM	SYSTEM

Subroutine:	OUTNAT
Algorithm:	Routine outputs the model in NASTRAN format by calling in special output routines; it establishes the data to be passed to those routines; and finally, writes out the material cards. It starts by initializing switches and counters; then the element data blocks are retrieved; and subroutines are called to output the data. Finally, the NASTRAN MAT cards are output.
Input/Output:	KUNIT - output file for NASTRAN bulk data deck
Error Messages:	None
External Calls:	IOPAC OUTNAL OUTNHX OUTNR2 OUTNWT MAIDCH OUTNAX OUTNLM OUTNRO OUTCEL OUTGRD OUTNB2 OUTNQT OUTNT6
Argument List:	NR1 - sets the number of digits in the grid coordinate values
Important Variahles:	NELMT - number of elements in the group NTYPE - element type NVREC - current record being accessed from the data base
Common Blocks:	BLANK DBREC MATL PERM ELHEAD NASTRN NOHEAD

Subroutine:	OUTNAX
Algorithm:	Routine outputs the axisymmetric elements for NASTRAN. Follows the same process as the OUTNAL routine with minor changes for the CTRAPAX and CTRIAAX requirements.
Input/Output:	KUNIT - output unit for bulk data deck
Error Messages:	None
External Calls:	OUTPPK

Argument List:

IT	-	group number for the elements to be output
IBUFF	-	integer number array for the element data
BUFF	-	real number array for the element data
N1	-	number of rows in the IBUFF array
NPROP	-	integer number array for properties
PROP	-	real number array for properties
N2	-	number of rows in the PROP and PMAT arrays
IOLD	-	element number position array
N3	-	number of rows in the IOLD array
NPMAT	-	integer number array for materials
PMAT	-	real number array for materials

Important Variables: Same as argument list.

Common Blocks:

CHAR	NASTRN	TEMP
ELHEAD	PERM	SYSTEM

Subroutine:	OUTNB2
Algorithm:	Routine outputs the beam element as a NASTRAN CBAR element using the same procedure set up for the general NASTRAN element output routine OUTNAL.
Input/Output:	KUNIT - output file for bulk data deck.
Error Messages:	None
External Calls:	IFINDN OUTBAR OUTNCD

Argument List:

IT	- position in NELGRH array of CBAR group
IBUFF	- array contains element identification data
N1	- number of rows in the IBUFF array
NPROP	- integer numbers in property array
PROP	- real numbers in property array
N2	- number of property table rows
IOLD	- element identification array
N3	- number of element identifications in IOLD
JBAR	- integer property card values
BAR	- real property card values
IBAR	- count of the number of CBAR output cards

Important Variables: Same as argument list

Common Blocks:

BLANK	DBREC	PINFLA	SYSTEM
CHAR	PERM	ELHEAD	

Subroutine:	OUTNCD
Algorithm:	Codes a real value into an 8-character output array for output to a file. Processes three numbers at a time - keeping the most significant digits.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	R4 - three element array of real numbers R8 - three element array of 8-character output
Important Variables:	Same as argument list
Common Blocks:	CHAR

Subroutine:	OUTNHX
Algorithm:	Output routine for the solid isoparametric elements. It follows the same format as OUTNAL, the general NASTRAN element output routine.
Input/Output:	KUNIT - output file for bulk data deck
Error Messages:	None
External Calls:	OUTPPK

Argument List:

IT	- group number for the elements to be output
IBUFF	- integer number array for the element data
BUFF	- real number array for the element data
N1	- number of rows in the IBUFF array
NPROP	- integer number array for properties
PROP	- real number array for properties
N2	- number of rows in the PROP and PMAT arrays
IOLD	- element number position array
N3	- number of rows in the IOLD array
NPMAT	- integer number array for materials
PMAT	- real number array for materials

Important Variables: Same as argument list

Common Blocks:

CHAR	NASTRN	TEMP
ELHEAD	PERM	SYSTEM

Subroutine:	OUTNLM
Algorithm:	Routine outputs the forces or moments in NASTRAN format. Cycles through the pointer array to retrieve the force or moment data from the geometry data base. The data is then output as NASTRAN bulk data cards.
Input/Output:	KUNIT - output file for the bulk data deck IOPAC - retrieves force/moment data from geometry data base
Error Messages:	None
External Calls:	IOPAC
Argument List:	None
Important Variables:	MF - array with node number, load number, and coordinate data for the nodes FM - force or moment data array
Common Blocks:	BLANK MOHEAD NOHEAD PERM DBREC

Subroutine:	OUTNQT
Algorithm:	Routine outputs the higher order bending elements in NASTRAN CQUAD4 and CTRIA3 format. It uses the same procedure as the general element output routine OUTNAL.
Input/Output:	KUNIT - output file for bulk data deck
Error Messages:	None
External Calls:	OUTPPK
Argument List:	IT - group number for the elements to be output
	IBUFF - integer number array for the element data
	BUFF - real number array for the element data
	N1 - number of rows in the IBUFF array
	NPROP - integer number array for properties
	PROP - real number array for properties
	N2 - number of rows in the PROP and PMAT arrays
	IOLD - element number position array
	N3 - number of rows in the IOLD array
	NPMAT - integer number array for materials
	PMAT - real number array for materials
Important Variables:	Same as argument list
Common Blocks:	CHAR NASTRN TEMP
	ELHEAD PERM SYSTEM

Subroutine:	OUTNRO
Algorithm:	This routine outputs the axial rod elements as NASTRAN CROD elements using the general OUTNAL procedure.
Input/Output:	KUNIT - output unit for bulk data deck
Error Messages:	None
External Calls:	None
Argument List:	IT - group number for the elements to be output
	IBUFF - integer number array for the element data
	BUFF - real number array for the element data
	N1 - number of rows in the IBUFF array
	NPROP - integer number array for properties
	PROP - real number array for properties
	N2 - number of rows in the PROP and PMAT arrays
	IOLD - element number position array
	N3 - number of rows in the IOLD array
	NPMAT - integer number array for materials
	PMAT - real number array for materials
	IP - array containing the compressed property identifications
Important Variables:	Same as argument list
Common Blocks:	CHAR PERM ELHEAD
	NASTRN SYSTEM

Subroutine:	OUTNR2
Algorithm:	Routine outputs the CONROD and CELAS2 elements in NASTRAN format. First it determines the element type and data record pointers and then cycles through the data array formatting and writing the correct bulk data deck cards.
Input/Output:	KUNIT - output unit for bulk data deck
Error Messages:	None
External Calls:	None
Argument List:	IT - group number for the elements to be output
	IBUFF - integer number array for the element data
	BUFF - real number array for the element data
	N1 - number of rows in the IBUFF array
	NPROP - integer number array for properties
	PROP - real number array for properties
	N2 - number of rows in the PROP array
	IOLD - element number position array
	N3 - number of rows in the IOLD array
Important Variables:	Same as argument list
Common Blocks:	CHAR SYSTEM
	ELHEAD PERM

Subroutine:	OUTNT6
Algorithm:	Routine outputs the higher order triangular membrane element in NASTRAN CTRIM6 format. It follows the general element output procedure used in OUTNAL.
Input/Output:	KUNIT - output unit for bulk data deck
Error Messages:	None
External Calls:	OUTPPK

Argument List:

IT	- group number for the elements to be output
IBUFF	- integer number array for the element data
BUFF	- real number array for the element data
N1	- number of rows in the IBUFF array
NPROP	- integer number array for properties
PROP	- real number array for properties
N2	- number of rows in the PROP and PMAT arrays
IOLD	- element number position array
N3	- number of rows in the IOLD array
NPMAT	- integer number array for materials
PMAT	- real number array for materials

Important Variables: Same as argument list

Common Blocks:

CHAR	NASTRN	TEMP
ELHEAD	PERM	SYSTEM

Subroutine:	OUTNWT
Algorithm:	Routine outputs the wedge and tetrahedron elements in NASTRAN CWEDGE and CTETRA formats. It first sets the type and pointer variables and then processes the data arrays. Next, the connectivities and element card data are formatted; and finally, the data is written to the KUNIT file.
Input/Output:	KUNIT - output file for bulk data deck
Error Messages:	None
External Calls:	None
Argument List:	IT - index into the pointer arrays for a particular group
	IBUFF - element connectivity data
	N1 - number of rows in the IBUFF array
	IOLD - property card pointers
	N3 - number of rows in the IOLD array
Important Variables:	Same as argument list
Common Blocks:	CHAR PERM ELHEAD
	NASTRN SYSTEM

Subroutine:	OUTOPT
Algorithm:	This routine outputs the model data in OPTSTAT format. It starts by retrieving the model data, such as the coordinate, connectivity, and material information for storage in the appropriate arrays. This information is then output to KUNIT using a series of WRITE statements to correctly format the arrays of data.
Input/Output:	KUNIT - output unit for the data deck
Error Messages:	None
External Calls:	OUTAOG ZRAYB IOPAC OUTAOL OUTOP1
Argument List:	None
Important Variables:	ISOTRN - isotropic material counter NISOTR - composite material counter XYZ - node coordinate array
Common Blocks:	NOHEAD BLANK OPTIND DBREC PERM MOHEAD MATL

Subroutine:	OUTOP1
Algorithm:	Subroutine retrieves the element connectivity and material data for output to OPTSTAT. The isotropic and composite material tables are read from the data base. The element connectivity and material pointers are then read and the routine cycles through the element list. The element information is placed in the output arrays based upon the element type and material data.
Input/Output:	IODB - direct access I/O from the GEOM data base IOPAC - packs/unpacks tables from the data base Unit 7 - terminal output for messages
Error Messages:	*** ERROR *** NUMBER OF OPTSTAT ELEMENTS WERE = ____ MAXIMUM ALLOWED IS 160
External Calls:	IODB JFINDG IOPAC OUTOP2
Argument List:	None
Important Variables:	MEMBS - number of members (elements) to be output MA,MB,MC,MD - arrays holding nodes 1-4 of the various elements NNODES - array of element type numbers
Common Blocks:	NOHEAD MOHEAD BLANK DBREC ELHEAD PERM OPTIND MATL

<u>Subroutine</u>:	OUTOP2
<u>Algorithm</u>:	This routine records the ANALYZE or OPTSTAT element connectivity outputs. It cycles through the output elements checking the current element number against the corresponding input element number. When necessary it changes the numbers to match the input number.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	NZ - array of reordered element numbers
	NW - array of current input element numbers
	LAM - array of pointers to composite elements
	MEMBS - the number of members (elements) in the model
	ISIZE - limit on the number of the elements in the model
	NISOTR - number of composite materials
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine:	OUTPPK	
Algorithm:	Routine processes the property card identifications for a group of elements into a compressed table of required data. Basically it checks new values against the previously stored tables to see if there are any differences in values. If there are, the property is added to the table list, otherwise the property number is changed to the previously stored value.	
Input/Output:	None	
Error Messages:	None	
External Calls:	None	
Argument List:	PMAT	- compressed table of real property values
	NPMAT	- compressed table of property identifications
	PROP	- property values to be checked against the table
	N2	- number of rows in the PMAT, NPMAT, and PROP arrays
Important Variables:	Same as argument list	
Common Blocks:	TEMP	

Subroutine:	OUTPUT
Algorithm:	Routine is used to control the output subroutines. It decodes the command line input; sets appropriate switches; and finally, calls in the particular translator control routine.
Input/Output:	RDCARD - free read command input UNIT 7 - terminal output for messages
Error Messages:	*** OUTPUT CONTROL OPTION ________ NOT VALID *** OUTPUT PROGRAM TYPE ________ NOT SUPPORTED *** ERROR *** OUTPUT UNIT NUMBER _____ MUST BE GREATER THAN 20; REENTER *** ERROR *** PROBLEM _____ OPENING UNIT _____ FOR OUTPUT OF FILE _____ *** THE PROGRAM KEYWORD IS MISSING FOR THE OUTPUT CONTROL OPTION
External Calls:	NUMBER OUTNAT OUTANA OUTOPT RDCARD
Argument List:	None
Important Variables:	ISW - switch for the output translator type NR1 - number of digits to be output for real values
Common Blocks:	BLANK DBREC PERM SYSTEM

Subroutine:	PAGMOD
Algorithm:	Routine monitors the number of lines on the screen so that it can be erased. It also queries the user to permit a user controlled abort of a command which is listing data at the terminal.
Input/Output:	Unit 5 - free read terminal I/O Unit 7 - terminal output for messages
Error Messages:	None
External Calls:	JFRAME JCLOSE JIQERR
Argument List:	KKSYSM - terminal type ISTOP - switch used to skip the user prompt code * - alternate return
Important Variables:	Same as argument list
Common Blocks:	None

The following block of subroutines makes up the DISPLAY Module of CADS. These routines provide the display and plot functions for CADS. The routines in this block are:

PLOTGN	PLTHID
PLOTNO	PLTHLN
PLOTNR	PLTHMN
PLOTS	PLTHPL
PLTARW	PLTHSA
PLTBEG	PLTHSK
PLTBOF	PLTHST
PLTBOT	PLTHSV
PLTBO1	PLTHVR
PLTBO2	PLTHV1
PLTBO3	PLTLAY
PLTBO4	PLTMAG
PLTCMA	PLTMAT
PLTCSF	PLTMA1
PLTCSI	PLTMXN
PLTCTE	PLTNAT
PLTCTN	PLTNOD
PLTCTR	PLTPLS
PLTCVL	PLTPRP
PLTDCL	PLTRED
PLTDIS	PLTRNS
PLTDMP	PLTROT
PLTDOP	PLTRO1
PLTEID	PLTRVH
PLTELM	PLTSAF
PLTESW	PLTSA1
PLTES1	PLTSCL
PLTEXP	PLTSYM
PLTGNO	PLTWID
PLTHBR	PRSTR1
PLTHCF	PRSTR2
PLTHCK	

Subroutine:	PLOTGN
Algorithm:	This routine calls in the SETGEN subroutine for generating sets and then it sets up for the display routines. It begins by initializing the variables and setting up the scratch arrays for the number of nodes and elements. It then calls in the SET and DISPLAY module command routines.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** MODEL TOO LARGE FOR PLOTTING INCREASE NBLANK AND DIMENSION D IN MAIN BY _____
External Calls:	OUTGRD SETUP PLOTS SETGEN
Argument List:	None
Important Variables:	NBLANK - size of blank common NONODE - number of nodes in the model
Common Blocks:	BLANK PLOTCM ELHEAD PERM

Subroutine:	PLOTNO
Algorithm:	Routine outputs integer numbers to the terminal screen. It converts the number to characters; strips off the blanks; positions the margin; and finally, outputs the text string.
Input/Output:	Internal character file READ/WRITE
Error Messages:	None
External Calls:	J1STRG JCONVW JMARGN
Argument List:	AIH - horizontal screen position for the number AIV - vertical screen position for the number LV - not used ISW - switch for the type of number IPT1 - first number to be output IPT2 - second number to be output
Important Variables:	Same as argument list
Common Blocks:	PLOT SYSTEM

Subroutine:	PLOTNR
Algorithm:	Converts and outputs real numbers to the screen. This routine sets the output format; converts the number, and strips off the blanks before positioning and outputting the text string.
Input/Output:	Internal character file READ/WRITE
Error Messages:	None
External Calls:	J1STRG
Argument List:	AIH - horizontal screen position of the number AIV - vertical screen position of the number LV - not used ISW - number of characters to the right of the decimal point PT1 - number to be output IPT2 - not used K - number of blanks to precede the output number string
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine: PLOTS

Algorithm: Subroutine decodes the DISPLAY module commands and controls the output of display information to the terminal. First it sets a series of switches and then decodes the plot commands by setting the specific switches for that command. Next it calls the required routines depending on the previous commands. After calling PLTRED it draws the display lines at the screen and outputs any requested data values to the terminal. Next it does the end of frame and view box processing before finishing up with calls to the contour plot routines.

Input/Output:

Unit 7 - terminal output for messages

Unit 5 - terminal input for user inputs

Internal character file READ/WRITE

Error Messages:

*** PLOT OPTION NOT FOUND

*** MAT2 DATA BLOCK DOES NOT EXIST

External Calls:

CHANGE	OUTGRD	JEND	JVPORT	PLTCSI	PLTELM	PLTNOD
RDCARD	JFRAME	JWINDO	PLTCTR	PLTESW	PLTRED	IOROUT
JBEAM	JLSTYL	PLTBEG	PLTDCL	PLTROT	LIGRNO	JCLOSE
JMOVE	PLTBOT	PLTDMP	PLTEXP	PLTSAF	NUMBER	JDRAW
JOPEN	PLTCMA	PLTDIS	PLTHID	PLTSYM	EDITCT	JKEYBD
PLTLAY	PLTCSF	PLTDOP	PLTMAG	PLTWID	XYGRAF	EDITE6
PLTCTE	SETS	SETUP	SETETN			

Argument List:

IRET	- error return switch
H	- horizontal node position array
V	- vertical node position array
IDS	- array of nodes in the display list
LINES	- array of line connectivities in the display list
Z	- z coordinate array
IISW	- return switch for multiple set processing

Important Variables: Same as argument list

Common Blocks:	CHAR	DIBAUD	NOHEAD	PINFLA	PLTITL	PLOT
	READ	PLOTBD	ELHEAD	DBREC	TEMP	PLOTCM
	PLOTEL	BLANK	SCALAR	PERM	TKTRNX	D1TOKD

Subroutine:	PLTARW
Algorithm:	Routine plots arrowheads for vectors. Draws two sets of three vectors, one inside the other, in order to fill in the arrowhead.
Input/Output:	None
Error Messages:	None
External Calls:	JDRAW JMOVE
Argument List:	AIH - start horizontal position for the arrow AIV - start vertical position for the arrow ICODE - switch array for the number of arrows to be drawn H - horizontal offset for the arrow V - vertical offset for the arrow
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTBEG
Algorithm:	Calls all the initialization routines to start DI-3000 before the plots are started.
Input/Output:	None
Error Messages:	None
External Calls:	JBEAM JDINIT JIENAB JVSPAC JBEGIN JEND JSETER JWCLIP JDEVON JFILES JVPORT JWINDO JSETDB JDSIZE
Argument List:	ISW - not used
Important Variables:	None
Common Blocks:	None

Subroutine:	PLTBOF
Algorithm:	Routine outputs the CBAR offset values to the terminal. It checks the display list for CBAR elements and then determines the components to be output. These component values are then displayed at the respective element centroids.
Input/Output:	IODB - Data base input and output IOPAC - Packed I/O to data base
Error Messages:	None
External Calls:	IODB JCONVW JMOVE IOPAC JMARGN PLOTNO PLOTNR
Argument List:	N2 - number of elements in AIS AIS - list of element centroids and numbers
Important Variables:	Same as argument list
Common Blocks:	ELHEAD DBREC D1TOKD PLTITL MATL

Subroutine: PLTB01

Algorithm: Routine superimposes the deformed on the undeformed shape plots. It begins by saving the deformed coordinates and then determines the minimum and maximum scales and computes new screen positions for the model coordinates. Finally, it recalls the deformed coordinates, computes their locations and plots the deformed model to the screen.

Input/Output: None

Error Messages: None

External Calls:

IOROUT	JMOVE	PLTB02	PLTDMP
JDRAW	OUTGRD	PLTB03	PLTNOD
JLSTYL	PLTB01	PLTB04	

Argument List:

H	- horizontal screen positions
V	- vertical screen positions
LINES	- display line connectivity array
Z	- dummy array of Z coordinate values

Important Variables: Same as argument list

Common Blocks: BLANK
DITOKD
PERM

Subroutine:	PLTB01
Algorithm:	Routine computes the minimum and maximum sizes for the superimposed deformed or undeformed plots. It rotates the coordinates to the desired orientation and calls PLTMXN to get the minimum and maximum values.
Input/Output:	None
Error Messages:	None
External Calls:	PLTMXN
Argument List:	XX - array of x coordinates YY - array of y coordinates ZZ - array of z coordinates NSET1 - set of nodes matching the coordinates N1 - number of nodes in NSET1 TT - array of minimums and maximums returned
Important Variables:	Same as argument list
Common Blocks:	PLOTCM BLANK

Subroutine:	PLTB02
Algorithm:	Routine converts the model coordinates to horizontal and vertical screen positions. It uses the minimum and maximum values to scale the model coordinates to the maximum screen size.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	H - horizontal screen position returned
	XX - x coordinate values
	V - vertical screen position returned
	YY - y coordinate values
	ZZ - z coordinate values
	NSET1 - set array of nodes matching the coordinates
	N1 - number of nodes in NSET1
	TT - array of minimums and maximums
Important Variables:	Same as argument list
Common Blocks:	PLOTCM

Subroutine:	PLTB03
Algorithm:	This routine is a subset of the PLTROT subroutine. It contains the code used to determine which lines are common. PLTB03 determines which lines are within the plot and sets them up for plotting at the terminal.
Input/Output:	None
Error Messages:	None
External Calls:	IOROUT
Argument List:	H - horizontal screen position of the coordinates
	V - vertical screen position of the coordinates
	LINES - display line connectivity array
	J1 - number of output vectors
	I - switch for the line table name
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTB04
Algorithm:	PLTB04 determines the minimum and maximum coordinate values for the deformed or the undeformed plots. It checks the deformed min/max array against the undeformed minimum/maximum array and returns the final array.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	T1 - input minimum/maximum array for the deformed plot T2 - input minimum/maximum array for the undeformed plot T3 - output minimum/maximum array
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTCMA
Algorithm:	Routine sets the contour level values for the element material properties. First, it retrieves the material data and element material pointers. Next the routine cycles through the element list, loads the material values at the element nodes, and finally calls the PLTCVL routine to average the node material values to determine the contour line position.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** CONTOUR DATA BLOCK DOES NOT EXIST *** MAT2 DATA BLOCK DOES NOT EXIST *** THERE ARE ISOTROPIC MATERIAL PROPERTIES IN ELEMENT SET
External Calls:	GETMAT IOROUT IOPAC IFINDN PLTCVL
Argument List:	KFLAG - error return flag CNTR - array with material values at the nodes ICNTR - array with the number of values at each node NSET - set of display list element pointers VALUES - material values record IOLD - element numbers
Important Variables:	Same as argument list
Common Blocks:	MATL TEMP NASTRN D1TOKD ELHEAD DBREC PERM MAT12

Subroutine: PLTCSF

Algorithm: Routine determines the contour level values for the element stresses or forces. First, it retrieves the element pointers and stress or force data block. Next, the routine cycles through the element list retrieving the appropriate data components and storing the data values at the element's nodes. Finally, it calls PLTCVL to average the stress or force data values at the nodes.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

```
*** LOAD CASE ____ DOES NOT EXIST FOR ____ DATA

*** ____ DATA BLOCK DOES NOT EXIST

*** NO INPUT ON CADS DATABASE FOR ELEMENT TYPE ____

*** ELEMENT TYPE ____ HAS NO INFORMATION ON MASTER FILE

*** ELEMENT NO. ____ DOES NOT HAVE OUTPUT DATA

*** OPTSTAT ELEMENT ____ DOES NOT HAVE LAYER DATA

*** OPTSTAT ELEMENT ____ HAS LAYER DATA: NO STRESSES
```

External Calls:

```
IFINDN  IOROUT  UTLDBP
IODB    PLTCVL  IOPAC
```

Argument List:

KFLAG - error return flag
CNTR - array of data values at the nodes
ICNTR - array of the number of values at each node
NSET - set of element display list pointers
IOLD - array of actual element numbers
IBUFF - buffer record for data base I/O

Important Variables: Same as argument list

<u>Common Blocks</u>:	MATL	PLOTEL	D1TOKD	PLOT	PERM	HEADPP	PLOTBD
	ELHEAD	SYSTEM	TEMP	PLOTB2	DBREC	NASTRN	PLOTCM
	TYPE						

Subroutine:	PLTCSI
Algorithm:	Routine is used to determine contour values for the element size data. It begins by retrieving the property data and element pointers to that data. Next, PLTCSI cycles through the elements checking for the correct property components and places those values at the element nodes. Finally, it calls PLTCVL to average the node values.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** SIZE CONTOUR DATA BLOCK DOES NOT EXIST *** THERE ARE MIXED PROPERTY TYPES IN SET
External Calls:	IFINDN PLTCVL IOPAC IOROUT
Argument List:	KFLAG - error return flag CNTR - array of nodes with component values ICNTR - array of the number of values at each node NSET - element display list pointers VALUES - property data record
Important Variables:	Same as argument list
Common Blocks:	MATL DBREC TEMP PERM ELHEAD NASTRN D1TOKD

Subroutine:	PLTCTE
Algorithm:	Routine processes the element display list and determines the centroid of each element in screen coordinates. It cycles through the element list; and retrieves the element nodes and their screen positions. These node positions are then averaged to determine the element centroid. If the centroid is outside the screen window the element is not displayed.
Input/Output:	None
Error Messages:	None
External Calls:	IFINDN JCONWV IOPAC IOROUT
Argument List:	N2 - number of element centroids (output) IS - element display list pointer array H - array of node horizontal screen positions V - array of node vertical screen positions NSET1 - element display set list AIS - centroids of the display elements
Important Variables:	Same as argument list
Common Blocks:	BLANK NOHEAD TEMP MATL PERM ELHEAD NASTRN TKTRNX DBREC TYPE

Subroutine:	PLTCTN
Algorithm:	Routine processes the node display list to check for placement on the screen. If off the screen, then the node is not processed. Routine is used to place the node number and other data at the node without screen wraparound.
Input/Output:	None
Error Messages:	None
External Calls:	IOROUT JCONWV
Argument List:	N2 - number of nodes returned IS - node centroid pointer array H - node horizontal screen position array V - node vertical screen position array NSET1 - node set display list AIS - node centroid array
Important Variables:	Same as argument list
Common Blocks:	TKTRNX PERM TEMP

Subroutine:	PLTCTR
Algorithm:	Routine outputs the contour lines to the screen. It begins by plotting the boundary lines of the display and then retrieves the element connectivity and contour data blocks. Linear interpolation between the element nodes is used to contour the value lines and these are then output. Finally the margin information is output for the plot.
Input/Output:	None
Error Messages:	None
External Calls	IFINDN JDRAW IOROUT J1IGET PLTDOP IOPAC JMOVE J1STRG PLTDCL
Argument List:	H - node horizontal screen position array V - node vertical screen position array VALUES - contour values array LINES - connectivity array for the display NSET - set of elements for the display
Important Variables:	Same as argument list
Common Blocks:	PLOT TEMP D1TOKD TKTRNX ELHEAD DBREC NASTRN MATL PLOTCM

Subroutine:	PLTCVL
Algorithm:	Routine determines the contour level values at the node locations for the various element values. It cycles through the contour block averaging the values at each node and then calls PLTSCL to obtain the scaled levels for the contour values.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** ERROR OCCURRED IN CONTOUR LEVEL SCALING ROUTINE
External Calls:	IOROUT PLTSCL
Argument List:	KFLAG - error switch flag FLAG - scaling routine flag switch CNTR - real array of contour values at the nodes ICNTR - integer array of the number of values at each node
Important Variables:	Same as argument list
Common Blocks:	PERM TEMP DITORD

Subroutine:	PLTDCL
Algorithm:	Routine closes the current plot display, resets the screen window and finally reopens the terminal for output.
Input/Output:	None
Error Messages:	None
External Calls:	JCLOSE JWINDO JOPEN JVPORT
Argument List:	None
Important Variables:	None
Common Blocks:	D1TOKD

Subroutine: PLTDIS

Algorithm: Routine retrieves the node displacements or the eigenvectors and outputs them as values at the nodes. First it retrieves the correct data block and then cycles through the node display list. It searches for the requested node value components and outputs them to the screen. Finally it outputs the appropriate titles to the display margin.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

```
*** NO LOAD CASES STORED FOR ____ DATA

*** ERROR LOAD CASE ____ DOES NOT EXIST FOR ____ DATA
```

External Calls:

IODB	JMARGN	PLOTNR	PLTDOP
IOPAC	JMOVE	PLTCTN	UTLDBP
JCONVW	J1STRG	PLTDCL	

Argument List:

H	- horizontal screen position for the nodes
V	- vertical screen position for the nodes
IS	- array of node pointers for AIS
AIS	- array of node centroids
NSET1	- set of nodes in the display list

Important Variables:

VALUE	- node value array
LDCASE	- subcase number
MASTER	- master pointer record

Common Blocks:

MATL	D1TOKD	HEADPP	PLOTCM	PLOT
BLANK	TEMP	DBREC	PLOTBD	PLTITL
SYSTEM	TYPE	PERM	PLOTEL	

Subroutine:	PLTDMP
Algorithm:	Routine stores or retrieves the H and V arrays to provide additional scratch array area for plotting.
Input/Output:	IOROUT - dumps array to scratch file
Error Messages:	None
External Calls:	IOROUT
Argument List:	H - horizontal position array V - vertical position array IG - a switch: =1 will retrieve the H and V tables; =2 will store the H and V tables. N1 - number of values in the H and V arrays NAMEH - character variable for the name of the H array NAMEV - character variable for the name of the V array
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTDOP
Algorithm:	Resets DI-3000 with an open and close for the screen window.
Input/Output:	None
Error Messages:	None
External Calls:	JCLOSE JVPORT JOPEN JWINDO
Argument List:	None
Important Variables:	None
Common Blocks:	D1TOKD

<u>Subroutine</u>:	PLTEID
<u>Algorithm</u>:	Routine retrieves the element identification numbers for the element display list. These are then stored in the NSET1 array for output to the terminal screen.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	IOPAC
<u>Argument List</u>:	N2 - number of elements in the display list IS - pointer array to the elements in the display list NSET1 - output array with element numbers
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	ELHEAD DBREC MATL

Subroutine:	PLTELM
Algorithm:	Routine outputs the element information to the screen based upon the switches set in PLTRED by the user. First, it outputs the element labels as text strings, next it outputs the element numbers, or the element group-offset number, and finally calls PLTMAT or PLTPRP for the material and size data.
Input/Output:	None
Error Messages:	None

External Calls:

GETMAT	JMOVE	PLTCTE	PLTEID	PLTMA1
JCONVW	J1STRG	PLTDCL	PLTMAT	
JMARGN	PLOTNO	PLTDOP	PLTPRP	

Argument List:

H	- horizontal node position array
V	- vertical node position array
NSET1	- element set for the display list
ASET1	- dummy array passed to PLTPRP
IS	- element centroid pointer into AIS
AIS	- array of element centroids

Important Variables: ISWS - switch array for specifying outputs

Common Blocks:

PLOT	D1TOKD	MAT12	TEMP
TYPE	DBREC	PERM	PLOTCM
ELHEAD	NASTRN	PLTITL	

Subroutine:	PLTESW
Algorithm:	Routine selects the stress or force components to be output. First, it decodes the user command and transfers it to an appropriate area. Next it determines the switches to be set on each element and packs the switches into a word. The routine then processes the DISPLAY CLEAR command for previously set switches and the DISPLAY MODE commands which are used to set the specific output mode.
Input/Output:	IOPAC - performs packed I/O to the GEOM data base RDCARD - free read terminal command input Unit 7 - terminal output for messages
Error Messages:	*** COMPONENT ____ IS NOT VALID FOR ELEMENT TYPE ____ HELP ELEMENT TYPE WILL DISPLAY VALID COMPONENTS *** INSUFFICIENT TERMS FOR CLEAR OPERATION *** ____ IS INVALID ELEMENT TYPE *** ____ IS AN INVALID OUTPUT MODE *** ERROR *** TYPE ____ IS NOT A VALID ANALYSIS PROGRAM; REENTER *** ERROR *** PROGRAM TYPE ____ DOES NOT MATCH PROGRAM TYPE ____ ON POST DATA BASE; REENTER
External Calls:	RDCARD UTLSLS PLTES1 IOPAC
Argument List:	None

Important Variables:	NBTYPE - output mode type
	NELSW - array of component switches
	ELTYPE - array of valid element types

Common Blocks:	READ	PLOTEL	PERM	TEMP	PLOTBD	HEADPP
	SYSTEM	D1TOKD	PLOTB2	TYPE	DBREC	

Subroutine: PLTES1

Algorithm: This routine decodes the element type and component keywords for stress and force output. First, it checks the mode and valid element type. Next the routine searches the component names for valid names and outputs them for the HELP command.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

*** OUTPUT MODE AND PROGRAM MUST BE SET BEFORE ELEMENT COMPONENT SELECTION

*** FORMAT FOR HELP IS HELP ELEMENT TYPE REENTER

*** ____ IS INVALID ELEMENT TYPE

*** ELEMENT TYPE ____ CANNOT OUTPUT INDICATED INFORMATION

External Calls: None

Argument List:

MODE	- switch for the type of output
IG	- switch for help: 1=no help, 2=help
NELMTP	- element type number
NW	- number of possible components for the element
NF	- offset into the component name array for the element
*	- alternate return

Important Variables: Same as argument list

Common Blocks:

READ	PLOTEL	PERM	PLOTB2
TYPE	PLOTBD	SYSTEM	

Subroutine:	PLTEXP
Algorithm:	Routine plots elements as exploded displays. It cycles through the element display list retrieving the corner point node positions. New corner points are determined so that the element is shrunken about its centroid. The element lines are then drawn on the screen in the current line style. At the end of the routine the element local axis is determined and output if requested.
Input/Output:	None
Error Messages:	None

External Calls:

IFINDN	JDRAW	IOROUT	JPIDEX	JPOLGN
IOPAC	JLSTYL	JMOVE	JPINTR	

Argument List:

H	- horizontal node screen position array
V	- vertical node screen position array
NSET1	- element set display list
ICOL	- switch for color processing 0=no color; 1=color
ICOLS	- array with element types to be colored

Important Variables:

IBUFF	- element connectivity array buffer
NT	- element type number

Common Blocks:

D1TOKD	NASTRN	TKTRNX	MATL	SOLIDS
DBREC	PERM	TYPE	PINFLA	
ELHEAD	TEMP	TYPEN	PLOT	

Subroutine:	PLTGNO
Algorithm:	Routine plots the node numbers for elements generated during the NATURAL generation mode. Cycles through the node list, converts the binary number to a character string and outputs the string to the terminal.
Input/Output:	None
Error Messages:	None
External Calls:	J1STRG JMOVE
Argument List:	H - horizontal node screen position array V - vertical node screen position array
Important Variables:	Same as argument list
Common Blocks:	MATL PERM

Subroutine:	PLTHBR
Algorithm:	Routine generates new grid locations for hidden line plots of exploded views. It cycles through the coordinates for the hidden lines and scales them for exploded views.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	NTRP - number of corners to the element
	NEL - pointer into coordinates for the element
	T1 - total x axis value to be averaged
	T2 - total y axis value to be averaged
	T3 - total z axis value to be averaged
	RSCL - scale factor for the exploded views
	XYZ - array for the coordinates of the element
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTHCF
Algorithm:	This routine is the COEF routine for COSMIC's hidden line package. It determines the equations of lines and planes. It looks for matching coordinates and then determines the line segment and plane equations.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	X - array of x coordinates for the points
	Y - array of y coordinates for the points
	Z - array of z coordinates for the points
	XXX - storage array for the plane equations
	JXX - offset factor for the pointer into the CCC and XXX arrays
	NC - not referenced
	NS - number of points being processed
	CCC - storage array for the line segment equations
	LZ - offset factor for determining the point position in the CCC array
Important Variables:	Same as argument list
Common Blocks:	G03

Subroutine:	PLTHCK
Algorithm:	Routine is the CHECK routine from the COSMIC hidden line package. It solves for the points of intersection of the lines of the jth element with other relevant lines and planes.
Input/Output:	None
Error Messages:	None
External Calls:	None

Argument List:

XXX	- array from PLTHCF with the equations of the planes
CCC	- array from PLTHCF with the equations of the lines
NNO	- array with the counters for the elements to be checked
J	- not referenced
II	- counter for the number of lines to be checked
NC	- not referenced
XI	- storage array for the x coordinate of the intersections
YI	- storage array for the y coordinate of the intersections
NGX	- counter array for number of intersections
ZM	- maximum z value for checking the point
ZMI	- minimum z value for checking the point
RV	- maximum y value for checking the point
RVI	- minimum y value for checking the point
TGM	- minimum x value for checking the point
TGI	- maximum x value for checking the point
ZI	- storage array for z coordinate of intersection
LZ	- used to get offset into CCC array

Important Variables: Same as argument list

<u>Common Blocks:</u>	DAVE
	HEDG
	G03

Subroutine:	PLTHID
Algorithm:	Routine sets up element data for processing through the hidden line routines. It finds the maximum diagonal of the display to adjust the screen area. Next the routine cycles through the element display list retrieving the node coordinates and storing them in the correct arrays for the hidden line processors based upon the element type. Finally it cycles through the element list calling the hidden line processing routines.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** ERROR MORE THAN ___ FACES IN SET ___ NUMBER WAS ___ *** ERROR ______ ELEMENTS ARE NOT YET SUPPORTED FOR HIDDEN LINE PLOTS WILL CONTINUE PROCESSING

External Calls:

IFINDN	JCLOSE	JVPORT	PLTDOP
IOPAC	PLTHSK	JWINDO	PLTHBR
IOROUT	JOPEN	PLTDCL	PLTHMN

Argument List:

H	- horizontal node positions used for the x coordinate
V	- vertical node position used for the y coordinate
U	- scratch array used for the z coordinate
NSET1	- element set for the display list
NSET2	- node set for the display list
IBUFF	- element connectivity buffer record

Important Variables:

XYZ	- coordinate array of element faces for hidden line processing
NEL	- number of faces

Common Blocks:

TEMP	PLOTCM	TYPE	TYPEN	PERM	SCALAR
BLANK	ELHEAD	DBREC	D1TOKD	NASTRN	

Subroutine:	PLTHLN
Algorithm:	This is the LIN routine from the COSMIC hidden line package. It performs the executive functions for the hidden line processing. It first sets the counters and offsets into the working arrays and determines the Euler rotation angles. Next it stores the coordinate and pen positions and 3-D transformations for the points and calculates the line and plane equations for the grid points and relevant elements. Next PLTHLN sorts the coordinate points and relevant and polygon projections and intersected line segments before finally cycling through the intersection and line tables to actually plot the lines.
Input/Ouput:	None
Error Messages:	None
External Calls:	PLTHCF PLTHST PLTHV1 PLTHVR PLTHCK PLTHSV PLTHPL
Argument List:	X - x coordinates of the face points Y - y coordinates of the face points Z - z coordinates of the face points NP - number of points in the face NC - switch for the last face: 0=more faces, 1=last face
Important Variables:	Same as argument list.
Common Blocks:	BLANK SCALAR G03 HEDG

Subroutine:	PLTHMN
Algorithm:	Determines the pointers to the maximum and minimum nodes for a coordinate axis. It cycles through a given array searching for the minimum and maximum values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	IXMIN - minimum pointer returned IXMAX - maximum pointer returned ARRAY - array containing the real values to be searched IARRAY - array containing the pointers into ARRAY NUMB - number of values to be searched
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTHPL
Algorithm:	This is the PLT routine from the COSMIC hidden line package. It plots points governed by the IM and IJ switches. It determines the X and Y values for the current point and moves or draws to it.
Input/Output:	None
Error Messages:	None
External Calls:	JDRAW JMOVE
Argument List:	X1 - x coordinate array for defining the current point Y1 - y coordinate array for defining the current point IJ - switch for a draw or move IM - switch to reset IJ
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTHSA
Algorithm:	This is the STAT routine from the COSMIC hidden line package. It takes points of intersection from PLTHSV and picks the maximum and minimum x coordinates of the points. First it determines the projection of the point and then the minimum and maximum values.
Input/Output:	None
Error Messages:	None
External Calls:	None

Argument List:

MT	- number of points to be processed
NIT	- counter for an added line
IXR	- used to get the offset into the X21, Y21, Z21 arrays
X21	- storage array for the maximum and minimum x coordinates
Y21	- storage array for the corresponding y coordinates
Z21	- storage array for the corresponding z coordinates
IIA	- storage array for the move/draw switches for PLTHPL
IV	- array of values used to determine offsets into the CCC and XXX arrays
A,B,C	- coefficients for the line being studied
IK	- used to get the offset into the XXX array
XA	- x coordinate of the intersection points
YA	- y coordinate of the intersection points
ZA	- z coordinate of the intersection points
CCC	- array from PLTHCF used for the line segment equations
XXX	- array used to get the offsets into CCC; it came from PLTHCF
NC	- not referenced
LZ	- used to get the offset into the CCC array

<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	DAVE
	G03

Subroutine:	PLTHSK
Algorithm:	This is the SKETCH routine from the COSMIC hidden line package. It sets up the move or draw motion detectors. First it initializes internal variables and then searches for matching coordinates and stores the matches. Finally it sets the move switch and returns.
Input/Output:	None
Error Messages:	None
External Calls:	PLTHLN
Argument List:	X - x coordinates for the face being processed Y - y coordinates for the face being processed Z - z coordinates for the face being processed NP - number of corner points for the face NC - switch: 0=more faces in the plot; 1=the last face
Important Variables:	Same as argument list
Common Blocks:	SCALAR

Subroutine:	PLTHST
Algorithm:	This is the STATUS routine from the COSMIC hidden line package. It determines the visability of a point by drawing a line from the point in question to infinity and counting the number of times it crosses the boundaries of a relevant element.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	OJ - x value of the point being processed
	TMJ - y value of the point being processed
	XXX - array from PLTHCF with the plane equations
	TGM - minimum x storage array for the boundary check
	RV - maximum y storage array for the boundary check
	RVI - minimum y storage array for the boundary check
	TGI - maximum x storage array for the boundary check
	ZM - maximum z storage array for the boundary check
	NNO - array with offset pointers into the CCC array
	II - counter for the number of relevant elements to be checked
	H - not referenced
	IM - switch for the move or draw of a line
	JXT - not referenced
	ZJ - z value of the point being processed
	NC - not referenced
	ZMI - not referenced
	CCC - array from PLTHCF with the line equations
	LZ - factor for the offset into CCC
Important Variables	Same as argument list
Common Blocks:	G03

Subroutine:	PLTHSV
Algorithm:	This is the SOLVE routine from the COSMIC hidden line package. It solves for the intersection lines resulting from the intersection of the Jth element with other relevant elements. First it checks if the element is to be considered, determines the line equations and checks the boundary. Finally it determines the lines of intersection across the elements and stores the corresponding values.
Input/Output:	None
Error Messages:	None
External Calls:	PLTHSA

Argument List:

IXR	- passed to PLTHSA
J	- used for the offset into the XXX array
XXX	- array from PLTHCF used to get the offsets into CCC
CCC	- array from PLTHCF with the equations of the line segments
II	- counter for the number of relevant elements to check
NNO	- array with counters for the elements to be checked
NIT	- counter for added lines
X21	- dummy array for PLTHSA
Y21	- dummy array for PLTHSA
Z21	- dummy array for PLTHSA
IIA	- dummy array for PLTHSA
NC	- passed to PLTHSA
ZM,ZMI	- arrays with switch checks for determining the relevant elements
LZ	- factor used in getting the offsets into the CCC array

Important Variables: Same as argument list

Common Blocks: DAVE
G03

<u>Subroutine</u>:	PLTHVR
<u>Algorithm</u>:	This is the VSRTR routine supplied with the COSMIC hidden line package. It sorts an array of values for the hidden line package. Routine is an IMSL routine.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	A - array to be sorted LA - number of elements in A to be sorted IR - vector of length LA
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine:	PLTHV1
Algorithm:	This is the VSRT1 routine from the COSMIC hidden line package. It performs a partial sort for the hidden line package.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	A - array to be sorted LA - length of the elements to be sorted IR - scratch array of length LA
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTLAY
Algorithm:	Routine outputs composite layer data to the terminal. First finds out which actual elements were picked by the user in PLTWID and then retrieves the composite data for the elements. The selected data is then processed and output to the terminal as detailed composite element layer data.
Input/Output:	IOPAC - performs packed data I/O to the GEOM data base
Error Messages:	None

External Calls:

IOPAC	JRPLGN	PLTDCL	JCLOSE
JMOVE	J1STRG	PLTDOP	JFRAME
JRMOVE	PLTCTE	PLTEID	JOPEN

Argument List:

H	- array of horizontal grid positions
V	- array of vertical grid positions
NSET1	- element set for display
NP34	- integer array with composite layer data values
P34	- real array with composite layer data values
IS	- array of element centroid pointers
AIS	- array of element centroid positions

Important Variables: Same as argument list

Common Blocks:

MATL	ELHEAD
DBREC	TEMP
D1TOKD	

Subroutine:	PLTMAG
Algorithm:	Routine plots the margin information and lines after a plot is completed. It steps through the switches and outputs the margin text as required. Next it draws the separator lines at the correct locations and finally outputs the model orientation as a small axis system.
Input/Output:	IODB - performs I/O directly to the GEOM data base IOPAC - performs packed data I/O to the GEOM data base
Error Messages:	None

External Calls:

J1STRG	PLTDCL	JMOVE	IOPAC	JPINTR
JDRAW	PLTDOP	IODB	JPIDEX	JRPLGN

Argument List:

H	- array of horizontal coordinate positions
V	- array of vertical coordinate positions
ICOL	- switch for color processing 0=no color, 1=color
ICOLS	- array with element types to be colored

Important Variables: Same as argument list

Common Blocks:

D1TOKD	TYPE	PLOT	PLTITL	PLOTCN
TEMP	PLOTCM	SYSTEM	PERM	NASTRN
HEADPP	DBREC			

AD-A174 229 CADS - A COMPUTER AIDED DESIGN SYSTEM VOLUME 3 PROGRAM 3/4
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SEGUNDO CA NORTH AMERICAN AIRCRAFT D M C LESS ET AL
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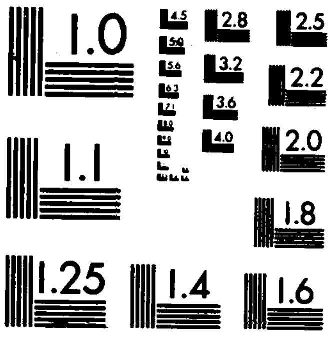
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1.6

Subroutine: PLTMAT

Algorithm: Routine outputs the element material information to the screen. It checks for the value types to be output and then cycles through the element list. For each element it retrieves the appropriate material values, positions the values around the element centroid and calls PLOTNR to output the actual value. It continues searching the material switches to output all requested properties for that element.

Input/Output: None

Error Messages: None

External Calls:

IOPAC	JMARGN	PLTDCL	JCONVW
J1STRG	JMOVE	PLTDOP	PLOTNR

Argument List:

N2	- number of elements in the set
IS	- array of the element pointers
AIS	- array of element centroids
H	- node point horizontal screen positions
V	- node point vertical screen positions
MAT1	- material array for the isotropic elements
M1	- number of rows in MAT1
MAT2	- anisotropic material array
M2	- number of rows in MAT2

Important Variables: Same as argument list

Common Blocks:

PLOT	ELHEAD	D1TOKD	MAT12	PLTITL	PLOTCM
MATL	TYPE	DBREC	PERM	NASTRN	TEMP

Subroutine:	PLTMA1
Algorithm:	This routine outputs the composite lamina properties to the terminal based upon the user requests. First it retrieves the components to be output. Next it sets up the material values for output before finally cycling through the element list to write out the values to the terminal.
Input/Output:	Unit 7 - terminal output for messages IODB - data base direct access I/O
Error Messages:	** NO COMPOSITE MATERIAL PROPERTIES **
External Calls:	IODB JCONVW PLOTNO PLTDOP IOPAC JMARGN PLOTNR J1STRG JMOVE PLTDCL
Argument List:	N2 - number of elements in IS and AIS IS - array with the element list to be plotted AIS - array with the centroids of the elements H - array with the horizontal screen positions of the nodes V - array with the vertical screen positions of the nodes NPLY - integer array for the composite material values PLY - real array for the composite material values
Important Variables:	Same as argument list.
Common Blocks:	PLOT D1TOKD PLTITL MATL DBREC PLOTCM ELHEAD PERM TEMP

Subroutine:	PLTMXN
Algorithm:	Routine searches an array for its minimum and maximum values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	XMIN - minimum value of the array
	XMAX - maximum value of the array
	ARRAY - array of values to be searched
	IARRAY - list of positions in ARRAY to be checked.
	NUMB - number of values in array IARRAY
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	PLTNAT	
Algorithm:	Routine plots elements as they are generated in the NATURAL generation routines. It gets the element's nodes; moves the node coordinates into a temporary array; and finally outputs the element line segments.	
Input/Output:	None	
Error Messages:	None	
External Calls;	IFINDN	
	JDRAW	
	JMOVE	
Argument List:	H	- array of horizontal node positions
	V	- array of vertical node positions
	IBUFF	- buffer of node connectivity defining the elements
	NST	- number of rows in IBUFF
	NTYPE	- the element type number
	KS	- start position in IBUFF for the element to be displayed
	KL	- end position in IBUFF for the element to be displayed
Important Variables:	Same as argument list	
Common Blocks:	NASTRN	MATL
	PERM	SOLIDS

Subroutine:	PLTNOD
Algorithm:	Routine outputs the node numbers and coordinates to the screen. First it puts the node numbers at the nodes using the plot set information. The routine then checks for the coordinate value output request and cycles through those values if necessary. Next, it outputs the suppression data if requested and finally outputs the external force and moment data as appropriate.
Input/Output:	None
Error Messages:	None

External Calls:

J1STRG	JMOVE	PLTCTN	FREUCK	IOPAC	JFINDG
JCONVW	PLOTNO	PLTDCL	JMARGN	PLOTNR	PLTDOP
FREPCK	PLTARW				

Argument List:

H	- horizontal node position
V	- vertical node position
IS	- array of node pointers for the plot
NSET1	- set of nodes for plotting
AIS	- centroids of the nodes on the plot
ICASE	- external load case number to be output

Important Variables:

CXYZ	- coordinates of the nodes in the model
ISWS	- switch array for the type of output information

Common Blocks:

BLANK	TKTRNX	PLTITL	PERM	TEMP	DBREC
D1TOKD	PLOTCM	PINFLA	PLOT	MATL	NOHEAD

Subroutine:	PLTPLS
Algorithm:	Routine outputs a plus sign (+) at the node locations for the node only plots. It also writes out the node number as a character string.
Input/Output:	None
Error Messages:	None
External Calls:	J1STRG JMOVE JCMARK JMARK
Argument List:	H - horizontal positions of the nodes V - vertical positions of the nodes N - number of nodes to be output
Important Variables:	NCXYZ - array of node numbers and their coordinates
Common Blocks:	BLANK

Subroutine:	PLTPRP
Algorithm:	Routine outputs the element size information to the screen based upon the user commands. First it outputs the correct titles to the plot margin and then cycles through the element list. It checks for the correct property table and then outputs the appropriate sizes to the terminal.
Input/Output:	IOPAC - performs packed data I/O to the data base
Error Messages:	None

External Calls:

IOPAC	JMARGN	PLTDCL	JCONVW	PLTBOF
J1STRG	JMOVE	PLTDOP	PLOTNR	

Argument List:

N2	number of elements in the display list
IS	element pointers for the display list
AIS	array of element centroid positions
H	node horizontal screen positions
V	node vertical screen positions

Important Variables:

GEDA	size value
NELGRH	array of element group/offset pointers to the property data
PM	property size record from the data base

Common Blocks:

ELHEAD	D1TOKD	TEMP	PLTITL
DBREC	NASTRN	TYPE	PLOTCM
MATL	PERM	PLOT	

Subroutine PLTRED

Algorithm: Routine decodes the user keywords from the PLOT command. It clears the display switches and checks the input keywords against the valid options. It sets the output switch for the command. Finally, it checks the virtual and screen window sizes before returning to PLOTS.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

```
*** INVALID KEYWORD ________ FOUND FOR PLOT OPTION

*** PLOT WINDOW ________ IS UNDEFINED

*** NUMBER OF CONTOURS REQUESTED EXCEEDS MAXIMUM

*** ELEMENT TYPE ________ IS NOT VALID FOR CURRENT
    PROGRAM MODE

*** ELEMENT OUTPUT INDICATORS DO NOT MATCH REQUESTED
    TYPE

*** _____ IS NOT A VALID MATERIAL CONTOUR REQUEST

*** INVALID CONTOUR REQUESTED
```

External Calls:

CHANGE
NUMBER

Argument List:

*	- alternate error return
ICASE	- external load case number for data display

Important Variables: None

Common Blocks:

READ	TYPE	BLANK	PERM	TEMP
PLOTEL	PLOTBD	TKTRNX	PLTITL	PLOTCM
TYPEN	SYSTEM	PLOT	D1TOKD	

Subroutine:	PLTRNS
Algorithm:	Reverses two values. It simply switches I1 to I2 and I2 to I1.
Input/Output:	None
Error Messages:	None
External Messages:	None
Argument List:	I1 - first input value to be switched I2 - second input value to be switched
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine: PLTROT

Algorithm: Routine performs coordinate rotations based upon the user requests. First it decodes the ROTATE command and retrieves the undeformed coordinates. Then it checks for a deformed shape request and selects the deformations if needed. Next it calls PLTRVH to rotate the coordinates and define the H and V arrays. Finally the routine goes through the line connectivity array optimizing for plotting in the given view.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

*** ROTATE KEYWORD ________ IS NOT VALID

*** LOAD CASE HAS NOT BEEN SET CORRECTLY, CASE = _____

*** MODE MUST BE SET TO DISP OR EIGE BEFORE ELEMENT COMPONENT SELECTED

*** NO LOAD CASES STORED FOR DISPLACEMENTS OR EIGENVECTORS

*** NODE NO. ________ DOES NOT HAVE OUTPUT DATA

External Calls:

CHANGE	IOPAC	OUTGRD
IODB	IOROUT	PLTRVH

Argument List:

IPASS	- switch to mark the first pass through the routine
H	- horizontal screen positions for the nodes
XX	- x coordinate values of the nodes
V	- vertical screen positions of the nodes
YY	- y coordinate values of the nodes
ZZ	- z coordinate values of the nodes
LINES	- node connectivity of the display lines
NSET1	- pointer to the node positions in the node data arrays

Important Variables: Same as argument list

Common Blocks:

READ	PLOTEL	DBREC	TEMP	HEADPP
MATL	D1TOKD	PLOTCM	BLANK	PERM

Subroutine:	PLTR01
Algorithm:	This routine computes the node screen location during the node generation and outputs a plus sign at that point. It uses the current rotation and screen size factors to compute the rotated and screen positions for the node. Finally, it determines the node number and outputs the plus sign to the screen.
Input/Output:	None
Error Messages:	None
External Calls:	J1STRG JCMARK JMOVE
Argument List:	K1 - node position in the coordinate array
Important Variables:	CXYZ - node coordinate array
Common Blocks:	BLANK NATDSP D1TOKD PLOTCM

Subroutine:	PLTRVH
Algorithm:	Routine converts the real node coordinate to the screen coordinate based upon the requested rotation. First it establishes the rotation angles and cycles through the node coordinates making up the rotated coordinate arrays. Next it determines the minimum and maximum values of the coordinates and finally factors the coordinates to the screen size.
Input/Output:	None
Error Messages:	None
External Calls:	PLTMXN
Argument List:	H - horizontal screen position of the nodes
	XX - rotated x coordinate of the nodes
	V - vertical screen position of the nodes
	YY - rotated y coordinate of the nodes
	ZZ - rotated z coordinate of the nodes
	NSET1 - set of display node pointers
	N1 - number of values in NSET1
Important Variables:	CL - array of rotation angles
Common Blocks:	BLANK PLOTCN
	D1TOKD PLOTCM

Subroutine:	PLTSAF
Algorithm:	Routine outputs the element stress and force components for the display list of elements. It checks for the correct data blocks and pointer records for the requested data type. Next it cycles through the element list and retrieves the components based on the requested data type. Finally it outputs the values to the screen.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** LOAD CASE ______ DOES NOT EXIST FOR ______ DATA
	*** _______ DATA BLOCK DOES NOT EXIST
	*** NO INPUT ON CADS DATABASE FOR ELEMENT TYPE ______
	*** ELEMENT TYPE ____ HAS NO INFORMATION ON MASTER FILE
	*** ELEMENT NO. ____ DOES NOT HAVE OUTPUT DATA

External Calls:	IODB	JCONVW	PLOTNR	PLTDOP
	IOPAC	JMARGN	PLTCTE	UTLDBP
	J1STRG	JMOVE	PLTDCL	

Argument List:	H	- horizontal node position
	V	- vertical node position
	IS	- array of element list pointers
	AIS	- array of element centroids
	NSET	- set of elements to be displayed
	IOLD	- array of element numbers
Important Variables:	LDCASE	- load case
	MASTER	- master pointer to display data
	VALUE	- array of output values

Common Blocks:

MATL	SYSTEM	PLOT	DBREC	PLOTBD	PLTITL
ELHEAD	D1TOKD	PLOTB2	HEADPP	PLOTCM	
PLOTEL	TYPE	PERM	NASTRN	TEMP	

Subroutine:	PLTSA1
Algorithm:	Routine retrieves a subset of the material property values for contour plots. First it gets E, G, and Poisson's ratio from the isotropic arrays and then retrieves the modulus arrays from the MAT2 data records.
Input/Output:	None
Error Messages:	None
External Calls:	IOPAC
Argument List:	MAT1 - isotropic material array NV1 - number of isotropic materials NV1R - data record for the isotropic materials MAT2 - anisotropic material array NV2 - number of anisotropic materials NV2R - record number for the anisotropic materials
Important Variables:	Same as argument list
Common Blocks:	MATL DBREC

Subroutine:	PLTSCL
Algorithm:	Routine scales the default contour levels to "nice" values of 1.0, 2.0, 2.5, or 5.0. It uses the minimum and maximum values to be scaled, determines the power of ten to be used, and then cycles through 14 contour levels to determine their respective values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	CMAX - maximum value CMIN - minimum value FLAG - error return flag
Important Variables:	CLEVEL - array of contour level values
Common Blocks:	D1TOKD

Subroutine:	PLTSYM
Algorithm:	This routine outputs a symbol at a specified screen location using the JMARK routine.
Input/Output:	None
Error Messages:	None
External Calls:	JCMARK JMARK
Argument List:	NOPT - option switch for the symbol type AIH - horizontal position for the symbol AIV - vertical position for the symbol
Important Variables:	Same as argument list
Common Blocks:	TKTRNX

Subroutine:	PLTWID
Algorithm:	Routine does the window processing for the VIEW, PORT, and WINDOW end of plot commands. First it positions the VIEW processing by retrieving corner points, using the cursor, of boxes to be expanded. Next it does PORT and WINDOW processing by retrieving the port or window numbers, title, and locations. This information is stored for up to 9 windows or ports. Finally it checks for additional values to be displayed on the screen and decodes those parameters as needed.
Input/Output:	None
Error Messages:	None
External Calls:	J1STRG JKEYBD JPOLGN PLTRNS JMOVE JCLOSE JLOCAT PLTDCL JCONVW PLTDOP
Argument List:	None
Important Variables:	JTT - character switch for processing the command SWH, SWV - arrays with the corner points of the window boxes UWH, UWV - arrays with the virtual corner points of the boxes
Common Blocks:	TEMP PLTITL PLOTCM TKTRNX D1TOKD

Subroutine:	PRSTR1
Algorithm:	Routine stores the element property (size) values based upon the current group being processed. It brings in a data block from the temporary scratch file and updates the pointer values based upon that block. It then cycles through the block loading the property tables for permanent storage based upon the element type and allowed values.
Input/Output:	ND2 - scratch unit for direct access I/O Unit 7 - terminal output for messages
Error Messages:	*** NO PROPERTY BLOCK FOR GROUP ______ TYPE ______ *** ______ IS A BAD PROPERTY CODE FOR GROUP ______
External Calls:	None
Argument List:	IPARY - scratch area for the property blocks IPAREA - input array with the property table numbers for the group IPN - number of tables in IPAREA IPROP - output array of group properties MA2 - number of rows in IPROP NUV - not used JNDEX - index into the pointer table for the scratch unit NUMEL - number of elements in the group INJ - property id being processed LIST - list of property ids for the elements KS - last used position IG - switch for adding values
Important Variables.	Same as argument list

Common Blocks:	PERM	TRACK1	SYSTEM
	TEMP	READN	NASTRN

Subroutine:	PRSTR2
Algorithm:	Routine stores a list of property values for a given list of elements.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	PROP - array of real property values
	NR - number of rows in PROP
	RLIST - list of values to be placed in PROP
	LIST - list of element numbers for values placed in PROP
	K3 - number of values in LIST
	LOC - row location of values in PROP
PRSTR3 ENTRY:	PROP, NR, RLIST, LIST, K3, - same as PRSTR2
	LOCP - array with location of input values for storage in PROP
	NP - number of values in LOCP array
Important Variables:	Same as argument list
Common Blocks:	None

The following block of subroutines makes up the READ module of CADS. These routines provide the translation functions for CADS to read existing model data into the GEOMETRY data base for processing. The routines in this block are:

RDANAL
RDAOGS
RDAOLS
RDCARD
RDCAR1
RDCMIS
RDCONT
RDNASS
RDNAST
RDNAS1
RDNAS2
RDNAS3
RDNAS4
RDNAS5
RDNAS6
RDNATR
RDNBAR
RDNCRD
RDNGRD
RDNGR1
RDNMAT
RDNOUT
RDNPAC
RDNSHF
RDOPTS
RDOPT1
RDOPT2

Subroutine:	RDANAL
Algorithm:	Routine reads the ANALYZE program input data and sets it up for storage to the data base. First it clears the scratch arrays and reads the ANALYZE control cards. Next it reads in the property data, member connectivity data, and finally the coordinate data. RDAOGS is called to save the coordinate data. Finally, the applied loads are read in and stored by RDAOLS, and the element data is stored by RDCMIS.
Input/Output:	NUNIT - input unit for ANALYZE data
Error Messages:	None
External Calls:	RDAOGS ZRAYB RDAOLS RDCMIS
Argument List:	None
Important Variables:	PAT1 - array of property values XYZ - array of the coordinate values NNODES - array with the number of nodes for each element MA,MB,MC,MD - arrays with the node connectivities for the elements
Common Blocks:	BLANK MOHEAD DBREC NOHEAD PERM MATL

<u>Subroutine</u>:	RDAOGS
<u>Algorithm</u>:	Routine converts the ANALYZE and OPTSTAT coordinates for storing on the GEOM data base. It cycles through the number of joints (nodes) for the model placing the coordinates, node number and boundary condition data into records for output to the data base.
<u>Input/Output</u>:	IODB - routine for actual output to the data base.
<u>Error Messages</u>:	None
<u>External Calls</u>:	IODB
<u>Argument List</u>:	XYZ - array of coordinates for the nodes
	IB - boundary conditions of the nodes
	MM - dimension of the problem (2 or 3)
	JOINTS - number of joints or nodes in the model
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	BLANK DBREC MOHEAD
	NOHEAD PERM

<u>Subroutine</u>:	RDAOLS	
<u>Algorithm</u>:	Routine is used to pack the ANALYZE and OPTSTAT external load data for storing on the GEOM data base. It cycles through the input load array and places the values into appropriate positions in a load record. These records are then stored to the data base.	
<u>Input/Output</u>:	IODB - routine for direct access data base I/O	
<u>Error Messages</u>:	None	
<u>External Calls</u>:	IODB	
	ZRAYB	
<u>Argument List</u>:	FIN - array with the input loads	
	LL - load case number	
<u>Important Variables</u>:	Same as argument list	
<u>Common Blocks</u>:	NOHEAD	PERM
	MOHEAD	DBREC

Subroutine: RDCARD

Algorithm: RDCARD performs the free read processing of user input commands. It reads a record into the CARD working buffer and then cycles through the characters filling the HOLD array with the character strings making up the individual variables.

Input/Output:

NUNIT	- input control record unit
Unit 7	- terminal output for messages

Error Messages:

*** TRUNCATION WILL OCCUR ON THE FOLLOWING CARD _____

*** MAXIMUM WORDS FOR ARRAY EXCEEDED, WORDS INPUT _____

External Calls: NUMBER

Argrument List:

PROMPT	- prompt string, usually the name of the calling routine
MENU	- not used
*	- alternate routine for error
NUNIT	- input unit for the command record
HOLD	- variable array returned as CHARACTER*8 words
LHOLD	- variable array returned as CHARACTER*1 words
NVAR	- number of variables in HOLD

Important Variables: Same as argument list

Common Blocks:

CHAR
SYSTEM
READCM

Subroutine:	RDCAR1
Algorithm:	This routine is essentially the same as the RDCARD routine except that it is used in the NATURAL generation modules. RDCAR1 will echo the user input commands to unit 3 for future use and/or modification of a steering file.
Input/Output:	NUNIT - input unit for control cards
	Unit 7 - terminal output for messages
	Unit 3 - control card echo file
Error Messages:	*** TRUNCATION WILL OCCUR ON THE FOLLOWING CARD _____
	*** MAXIMUM WORDS FOR ARRAY EXCEEDED, WORDS INPUT _____
External Calls:	NUMBER
Argrument List:	PROMPT - prompt string, usually the name of the calling routine
	MENU - not used
	* - alternate routine for error
	NUNIT - input unit for the command record
	HOLD - variable array returned as CHARACTER*8 words
	LHOLD - variable array returned as CHARACTER*1 words
	NVAR - number of variables in HOLD
Important Variables:	Same as argument list
Common Block:	CHAR
	SYSTEM
	READCM

Subroutine:	RDCMIS
Algorithm:	Routine stores the element connectivities, sizes, and material data for ANALYZE and OPTSTAT to the data base. It loads arrays for the elements with their input connectivity data. These are then stored to the data base as groups of elements. The material property table is stored by IODB since it requires no rearrangement before being processed.
Input/Output:	IODB - performs data base direct access I/O
Error Messages:	None
External Calls:	GROUPS IODB ZRAYB
Argument List:	NMAT - number of material properties MEMBS - number of elements (members)
Important Variables:	ICAO - element correspondance table I2C,I3C,I4C,I5C - arrays with the element connectivities I2P,I3P,I4P,I5P - arrays with the element sizes
Common Blocks:	NOHEAD DBREC MATL TEMP ELHEAD MOHEAD BLANK PERM

Subroutine:	RDCONT
Algorithm:	Routine controls the selection of the READ translator subroutines. It starts by setting switches, reading and decoding the command input, and finally calls in the correct translator module.
Input/Output:	RDCARD - free read command inputs Unit 7 - terminal output for messages
Error Messages:	*** READ CONTROL OPTION ______ NOT VALID *** READ PROGRAM TYPE ______ NOT SUPPORTED *** ERROR *** INPUT UNIT NUMBER (_) MUST BE GREATER THAN 20; REENTER *** YOU SHOULD HAVE SIX VALUES IN THE ABOVE ORDER - REENTER *** ERROR *** FILE NAME _____ DOES NOT EXIST REENTER NAME *** ERROR *** FILE NAME _____ ON UNIT _____ CANNOT BE OPENED; PROBLEM: _____ *** THE PROGRAM KEYWORD IS MISSING FOR THE READ CONTROL OPTION

External Calls:	CHANGE	NUMBER	RDCARD	RDNATR	UTLLTG
	IOHEAD	PLTBEG	RDNAST	RDOPTS	ZRAYB
	LIGRNO	RDANAL	RDNASS	START1	

Argument List:	None

Important Variables: ISW - switch for the program type being processed

NVREC - next valid record

Common Blocks:

READ	PLOTCM	MOHEAD	NATDSP	PINFLA
TYPE	ELHEAD	BLANK	PERM	
CHAR	DBREC	NASTRN	SYSTEM	

Subroutine:	RDNASS
Algorithm:	Routine controls the translation and storage of NASTRAN bulk data decks to the geometric data base. First it resets the pointers and then cycles through the types of data cards calling in the appropriate routine to process the data.
Input/Output:	ND2 - direct access unit to read the initial link record Unit 7 - terminal output for messages
Error Messages:	*** INSUFFICIENT MATERIAL WORKING ROOM (MAT1) *** INCREASE BLANK COMMON BY ________ INSUFFICIENT WORKING AREA FOR ________ CONRODS
External Calls:	RDNAS1 RDNAS4 RDNMAT RDNAS6 RDNAS2 RDNAS5 RDNAS3
Argument List:	NS - switch for sorting; if NS=0, bulk data was already sorted
Important Variables:	LOCATE - array which points to the data card types to be processed D - scratch array for in-core processing NTERM - number of data values per card type
Common Blocks:	TRACK1 PERM NASTRN ELHEAD BLANK TEMP DBREC READN

Subroutine:	RDNAST
Algorithm:	This is the first routine to process a NASTRAN bulk data deck. It reads in a card; determines the type; decodes the data; and stores it on a temporary scratch file.
Input/Output:	NUNIT - input unit for the NASTRAN data deck Unit 10 - output scratch unit Unit 7 - terminal output for messages
Error Messages:	*** CONTINUATION CARD FOR CIHEX ELEMENT _____ IS MISPLACED OR MISSING: ELEMENT WILL NOT BE PROCESSED *** COMBINATION OF AXISYMMETRIC AND STANDARD ELEMENTS IS NOT ALLOWED *** BULK DATA INPUT TERMINATED ABNORMALLY BEGIN BULK CARD COULD BE MISSING *** CONTINUATION CARD - IS MISPLACED OR MISSING
External Calls:	IODB RDNGRD ZRAYB RDNBAR IOPAC RDNOUT ZRAYI RDNSHF
Argument List:	ISPC - switch for processing SPC cards
Important Variables:	BUFFER - buffer for processing a NASTRAN card NUMBA - array to track the number of cards of each data type NTERM - number of terms on a bulk data deck card
Common Blocks:	BLANK MATL CHAR PINFLA TRACK1 NOHEAD SYSTEM DBREC PERM MOHEAD TEMP READN NASTRN

Subroutine:	RDNAS1
Algorithm:	Routine controls the sorting of NASTRAN input data decks. It brings in the data type; calls in the sort routine; and saves the sorted data on a scratch file. It cycles through the various element types until completed.
Input/Output:	ND2 - scratch file used for temporary NASTRAN storage Unit 7 - terminal output for messages
Error Messages:	*** INSUFFICIENT IN CORE SORT AREA AVAILABLE ______
External Calls:	SORTQ
Argument List:	INDEX - pointer into the LOCATE array for data type position IROW - number of variables per data card
Important Variables:	LOCATE - array with locations of the data types on a scratch file AREA - in-core sort array filled from the scratch file
Common Blocks:	TRACK1 BLANK READN

Subroutine:	RDNAS2
Algorithm:	This routine sets up and stores CONROD information to the geometric data base. It reads sorted elements, resolves the material identifications; places elements in groups, and writes data to the data base. In resolving material information it checks that the material number of the CONROD matches a previously defined MAT1 card.
Input/Output:	ND2 - scratch NASTRAN data file Unit 7 - terminal output for messages
Error Messages:	*** CONROD ELEMENT _______ HAS A BAD MATERIAL CODE *** READ ERROR IN SUBROUTINE RDNAS2
External Calls:	GROUPS
Argument List:	INARY - buffer array for a record of information INAREA - array used to store element data by card NW - number of variables per CONROD MATRIX - compressed array passed to GROUPS for output to the data base M1 - number of rows in MATRIX IPROP - array of property values for each element M2 - number of rows in IPROP IOLD - array with pointers to the material tables for the elements M3 - number of rows in IOLD NCO - number of elements in the group
Important Variables:	Same as argument list
Common Blocks:	TRACK1 PERM BLANK TEMP READN SYSTEM

Subroutine:	RDNAS3
Algorithm:	Routine stores NASTRAN elements to the data base. It retrieves a property data block for resolution between the element connectivity and property tables. It then outputs the connectivity for the elements and resolves their property and material callouts. Finally it compresses the data tables and establishes the pointer links needed to associate the properties and materials with the element group.
Input/Output:	ND2 - scratch data file with sorted NASTRAN data Unit 7 - terminal output for messages
Error Messages:	*** _____ ELEMENT _____ HAS A BAD PROPERTY CODE *** _____ ELEMENT _____ HAS A BAD MATERIAL CODE
External Calls:	GROUPS
Argument List:	INDEX - pointer into the LOCATE array for a scratch file position INARY - buffer for the data base record INAREA - array for the element connectivity NROW - rows in INAREA IPARY - buffer for the property table records IPAREA - array for the property values IPN - number of rows in IPAREA MATRIX - array passed to GROUPS for output to the data base MA1 - number of rows in MATRIX IPROP - compressed property table for the group being processed

Argument List: (continued)	MA2	- number of rows in IPROP
	IOLD	- pointer links from element groups to property tables
	MA3	- number of rows in IOLD
	NUMEL	- number of elements per element type

Important Variables: Same as argument list

Common Blocks:	TRACK1	TEMP	NASTRN	PERM
	BLANK	SYSTEM	CHAR	READN

Subroutine: RDNAS4

Algorithm: Routine stores the CELAS1 NASTRAN element. It follows the same procedures as the RDNAS2 routine for the CONROD elements with some additional property table processing for the CELAS1 element.

Input/Output:

ND2	- scratch file input
Unit 7	- terminal output for messages

Error Messages: *** ______ ELEMENT ______ HAS A BAD PROPERTY CODE

External Calls: GROUPS

Argument List:

INDEX	- pointer into the LOCATE array for a scratch file position
INARY	- buffer for the data base record
INAREA	- array for the element connectivity
NROW	- rows in INAREA
IPARY	- buffer for property table records
IPAREA	- array for property values
IPN	- number of rows in IPAREA
MATRIX	- array passed to GROUPS for output to the data base
MA1	- number of rows in MATRIX
IPROP	- compressed property table for the group being processed
MA2	- number of rows in IPROP
IOLD	- pointer links from element groups to property tables
MA3	- number of rows in IOLD
NUMEL	- number of elements per element type

Important Variables: Same as argument list

Common Blocks:

TRACK1	TEMP	NASTRN	PERM
BLANK	SYSTEM	CHAR	READN

Subroutine:	RDNAS5
Algorithm:	Routine stores CELAS2 NASTRAN elements to the data base. It follows the procedures used for CELAS1 in RDNAS4 but does not require any special property card processing.
Input/Output:	ND2 - scratch file for sorted NASTRAN data Unit 7 - terminal output for messages
Error Messages:	None
External Calls:	GROUPS
Argument List:	INDEX - pointer into the LOCATE array for a scratch file position INARY - buffer array for a record of information INAREA - array used to store element data by card NROW - number of rows in INAREA MATRIX - compressed array passed to GROUPS for output to the data base MA1 - number of rows in MATRIX IPROP - array of property values for the elements MA2 - number of rows in IPROP IOLD - array with pointers to the material tables for the elements MA3 - number of rows in IOLD NUMEL - number of elements in the group
Important Variables:	Same as argument list
Common Blocks:	TRACK1 TEMP NASTRN PERM BLANK SYSTEM CHAR READN

Subroutine:	RDNAS6
Algorithm:	Routine stores the solid CTETRA and CWEDGE NASTRAN elements. It follows the same procedures used to save the CONROD data, however, these elements do not use property size data so that processing is not required.
Input/Output:	ND2 - scratch file of NASTRAN sorted data Unit 7 - terminal output for messages
Error Messages:	*** _______ ELEMENT ______ HAS A BAD MATERIAL CODE
External Calls:	GROUPS
Argument List:	INDEX - pointer to the LOCATE array for a scratch file position INARY - buffer for the connectivity record for the data base INAREA - array of connectivity data by element NROW - number of rows in INAREA MATRIX - compressed array for output to GROUPS MA1 - number of rows in MATRIX IOLD - link array of pointers from the elements to the materials MA3 - number of rows in IOLD NUMEL - number of elements in the group
Important Variables:	Same as argument list
Common Blocks:	TRACK1 TEMP NASTRN PERM BLANK SYSTEM CHAR READN

Subroutine:	RDNATR
Algorithm:	This routine is the read controller for the NATURAL generation module. It starts by decoding the high level generation options and then calls in the routines needed to perform the specific option.
Input/Output:	RDCARD - free read command input routine Unit 7 - terminal output for messages

Error Messages:

```
*** CONTROL OPTION _____ NOT CORRECT FOR NATURAL MODE
    INPUT

*** NATURAL PROCESSOR MODULE NOT CORRECT _____

*** MODULE NAME HAS NOT BEEN ENTERED

*** MODULE: _________ CARD: ________
    EQUATE LIST HAS INCORRECT NUMBER OF TERMS
    NODE _____ DOES NOT PREVIOUSLY EXIST, NODE ____
         NOT ASSIGNED
    NODE _____ EXISTS AND CANNOT BE EQUATED
    MAXIMUM OF 200 EQUATED NODES ALLOWED AT ONE TIME
         USE ANOTHER EQUATE COMMAND FOR REST
```

External Calls:	IFINDN	NATELM	NUMBER	SETGEN	JEND
	IOPAC	NATNCT	OUTGRD	SORTQ	
	JFINDG	NATPRP	RDCARD	JCLOSE	

Argument List: None

Important Variables: None

Common Blocks:	BLANK	ELHEAD	NATDSP	SYSTEM
	READ	MOHEAD	NASTRN	READCM
	MATL	DBREC	PERM	

Subroutine:	RDNBAR
Algorithm:	Routine decodes and stores the local reference axis information for NASTRAN beams. It checks the reference flag, and interperts the BAROR card (if supplied). Next either the reference vector is read and the data is stored as a dummy node with a node number greater than 90000000 or the grid point defining the reference axis is read.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** BAROR CARD MUST PRECEDE ALL CBAR CARDS
	*** REFERENCE PLANE NOT SET UP BY BAROR CARD
External Calls:	None
Argument List:	ICODE - code for the axis flag: 1, by vector; 2 by nodes
	DATA - data array to be decoded
	IGRID - real or dummy node number of reference axis
	LOP - BAROR card check for reference values
Important Variables:	Same as argument list
Common Blocks:	MATL
	PERM
	TEMP

Subroutine:	RDNCRD
Subroutine:	Routine packs and stores the NASTRAN coordinate system data from the COORD cards. It stores the current coordinate data in an array and updates a counter. Once the counter reaches 82, it sends the entire coordinate array to the data base.
Input/Output:	IODB - performs data I/O directly to the GEOM data base
Error Messages:	None
External Calls:	IODB ZRAYI
Argument List:	IG - switch used to store data; 1=record not full continue; 2=record full so store NCORD - count on the number of different coordinate systems M - number of data values to be stored in the coordinate array NSYS - switch for the type of data - grid point or values JUNK - array with actual values for the reference system
Important Variables:	NDBREC - packed coordinate data array
Common Blocks:	DBREC NOHEAD

Subroutine:	RDNGRD
Algorithm:	First pass routine for the NASTRAN data. It reads the bulk data deck and sorts storable card to a scratch file for additional processing. The routine sets counters, checks the data card against acceptable formats, and then begins processing to decode and store GRID, BAROR, COORD, SPC, and RINGAX data cards.
Input/Output:	NUNIT - input unit for the NASTRAN bulk data Unit 10 - scratch unit for non-processed cards from this routine Unit 7 - terminal output for messages
Error Messages:	*** ONLY ONE BAROR CARD MAY APPEAR IN THE BULK DATA DECK *** ALL COORDINATE POINTS MUST REFERENCE BASE SYSTEM *** ALL CHILDREN MUST FOLLOW PARENT CARDS *** GRID POINT _____ IS UNDEFINED FOR COORDINATE SYSTEM _____
External Calls:	IFINDN OUTGRD RDNPAC NATSTR RDNCRD RDNGR1 NATTMS RDNSHF ZRAYI
Argument List:	None
Important Variables:	BUFFER - input buffer for a bulk data card GRIDAX - array of processed data types NT - type number for card being processed
Common Blocks:	BLANK MOHEAD CHAR PERM NOHEAD SYSTEM DBREC NASTRN ELHEAD MATL TEMP TRACK1

Subroutine:	RDNGR1
Algorithm:	Routine reads in and processes the NASTRAN force and moment cards. Loads a data array with given values from the input card and packs the array to the geometry data base as it is filled. After the data is read in, it is retrieved, sorted, and saved on the data base.
Input/Output:	IOPAC - performs packed geometry data base input/output IODB - performs direct I/O to the geometry data base
Error Messages:	None
External Calls:	IODB IOPAC SORTQ
Argument List:	IST - key array for the scratch file (unit 2) JUNK - decoded array of forces/moments NLFM - force or moment array for storage NLM - number of forces/moments IREC - number of records on the scratch file IG - 1= save NLFM to the scratch file 2= save NLFM to the permanent data base MS - key to the forces/moments pointers
Important Variables:	Same as argument list
Common Blocks:	MATL TRACK1 NASTRN BLANK DBREC NOHEAD PERM

Subroutine:	RDNMAT
Algorithm:	Routine stores the material property data tables to the geometric data base. It takes the input array of values MAT1 and stores them. Next it places pointer information in the MAT2 array for use in resolving the element connectivities, sizes, and materials for the model.
Input/Output:	None
Error Messages:	None
External Calls:	IOPAC
Argument List:	MAT1 - input array of material values
	N1 - number of rows in MAT1
	MAT2 - output array of pointer data from material storage
	N2 - number of rows in MAT2
	NMAT - number of materials being transferred
	NN - index into the data base header for the material data record
	MM - index in MAT2 for the total number of materials stored
	NDBREC - data base record for data
Important Variables:	Same as argument list
Common Blocks:	DBREC
	ELHEAD

Subroutine:	RDNOUT
Algorithm:	Stores sorted information to the direct access scratch file for data processing. It is used by the element store routines to retrieve material, property, and connectivity data for resolution of the NASTRAN bulk data deck information.
Input/Output:	ND2 - scratch direct access file Unit 7 - terminal output for messages
Error Messages:	*** SCRATCH FILE SPACE EXCEEDED __________
External Calls:	None
Argument List:	IREQ - the number of the NASTRAN data type being processed NWORD - number of words in the output string IOUT - output buffer array
Important Variables:	NEXT - pointer array for the next record of data for a given type IREC - record being read or written
Common Blocks:	TRACK1 BLANK READN

Subroutine:	RDNPAC
Algorithm:	Routine packs the node data to the data base. It sets up pointer arrays and transforms the coordinates using UTLTRN as needed.
Input/Output:	IODB - routine for I/O to the data base
Error Messages:	None
External Calls:	IODB UTLTRN
Argument List:	COORBA - scratch array for the transformed coordinates COORIN - scratch array for the original coordinates
Important Variables:	Same as argument list
Common Blocks:	BLANK PERM DBREC NOHEAD MATL

Subroutine:	RDNSHF
Algorithm:	Shifts data on a NASTRAN bulk data card so that it is right justified within an eight character field.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	II - number of values on the card
	DATA - scratch array of 8 character words
	LDATA - scratch array of 1 character words overlaid on DATA
	BUFFER - input card of 8 character words
	LBUFF - 1 character words overlaid on BUFFER
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine: RDOPTS

Algorithm: Routine reads in the OPTSTAT data decks for storage on the data base. First it reads the control cards followed by the material properties. These are saved in isotropic or composite material arrays as needed. Next, the element material numbers, connectivity and similar information is read. The node coordinate and boundary condition data is then read in and passed to RDAOGS. Finally the applied load information is read and passed to RDAOLS.

Input/Output:

NUNIT - input unit for the OPTSTAT data

IOPAC - performs packed data I/O to the GEOM data base

Error Messages: None

External Calls:

RDAOLS	RDOPT2	RDOPT1	IOPAC
RDAOGS	ZRAYB	RDCMIS	

Argument List: None

Important Variables:

MAT1	- isotropic material array
MATC	- composite material array
XYZ	- node coordinate data array
IB	- boundary condition data array
MA,MB,MC,MD	- element connectivity arrays
NNODES	- number of nodes per element

Common Blocks:

BLANK	MOHEAD	OPTIND	MATL
NOHEAD	PERM	DBREC	

Subroutine:	RDOPT1
Algorithm:	Routine computes the beta angle for composite material OPTSTAT elements. It cycles through the elements and if they are composite determines the element x direction from the connectivity. The material direction is then compared to this angle and the appropriate element beta angle is defined.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	XYZ - node coordinate array
Important Variables:	NNODES - array with the number of nodes per element MA,MB,MC,MD - arrays with the node connectivity for the elements
Common Blocks:	MATL OPTIND

Subroutine:	RDOPT2
Algorithm:	Routine stores the element data to the data base. First it saves the material properties to the data base and then cycles through the elements placing their connectivity and property data into arrays based upon the element type. These arrays are then packed and output to the data base.
Input/Output:	IODB - routine performs direct access I/O to the data base IOPAC - performs packed data I/O to the data base
Error Messages:	None
External Calls:	IODB ZRAYB IOPAC GROUPS
Argument List:	None
Important Variables:	I2C,I3C,I4C,I5C - arrays for the element connectivity data I2P,I3P,I4P,I5P - arrays for the element size data
Common Blocks:	NOHEAD DBREC MATL TEMP OPTIND ELHEAD MOHEAD BLANK PERM

The following block of subroutines makes up the SET module of CADS. These routines provide the SET processing functions for the definition of element and node sets for plotting. These routines are followed by several general routines for starting CADS, sorting arrays, and moving character blocks. The routines in this block are:

SETELM

SETETN

SETGEN

SETNOD

SETS

SETUP

SETUP1

SHIFT

SORTD

SORTQ

START

START1

Subroutine: SETELM

Algorithm: This routine generates element sets based upon user commands. It checks the command and transfers to the appropriate processing area. The first step is to get a list of elements based on the ID command. Next the keyword ALL is processed to get all of the elements in the model. The third section performs the union, intersection or exclusion of two previously defined sets. These sets are brought into core and operated on as required. Finally, the GROUP and TYPE keywords are processed by bringing element groups or types into core based on the requested GROUP number pointers and/or element TYPE pointers.

Input/Output: Unit 7 - terminal output for messages

Error Messages:

```
*** MODEL TOO LARGE TO BE PLOTTED BY ALL

*** SET _______ DOES NOT PREVIOUSLY EXIST

*** INVALID OPERATION SPECIFIED FOR ELEMENT SET

*** ELEMENT TYPE ________ NOT VALID

*** SET ________ IS A NULL SET
```

External Calls:

```
IFINDN   NUMBER   UTLMVW   UTLLTG
IOPAC    SETS     IOROUT
```

Argument List:

NSET1 - element set returned from the routine
NSET2 - working array for making the set
NSET3 - working array for input list and set checks

Argument List: (Continued)	NR	- number of 2 noded elements times the number of words required for the definition of the elements
	NT	- number of other elements times the number of words used to define them.

Important Variables: Same as argument list

Common Blocks:	BLANK	DBREC	PERM	SYSTEM	MATL
	READ	ELHEAD	TEMP	TYPE	
	CHAR	NOHEAD	NASTRN	TYPEN	

Subroutine: SETETN

Algorithm: Subroutine obtains the node numbers associated with a previously defined element set. It retrieves the given element set, uses IFINDN to locate the nodes defined for the element connectivities, and places them into the output set.

Input/Output: IOPAC - performs packed data I/O to the data base

Error Messages: None

External Calls: IFINDN
IOPAC

Argument List:

NSET1	- output set of node numbers
N1	- the number of values in NSET1
NSET2	- input set of elements
N2	- the number of values in NSET2
ICODE	- switch for NSET1 data: 0 gets the node numbers; 1 gets the pointers to the nodes

Important Variables: Same as argument list

Common Blocks:

DBREC	BLANK	TYPE	NASTRN
ELHEAD	PERM	MATL	SYSTEM

Subroutine:	SETGEN
Algorithm:	Routine controls the generation of sets. First it decodes the input command, sets the appropriate switches and then calls in the routines to process the command. Finally it sets up for the DISPLAY module and passes control to either the executive or display routines based upon the user input.
Input/Output:	Unit 6 - terminal output for the list and print commands Unit 7 - terminal output for messages
Error Messages:	*** SET NAME _________ IS NOT A PROPER NAME *** SET _________ DOES NOT EXIST *** NO RECORDS STORED TO DATA BASE *** INCORRECT NUMBER OF ARGUMENTS USED FOR PLOT *** SET _______ DOES NOT EXIST FOR PLOTTING
External Calls:	IFINDN SETELM SETETN LIGRNO IOROUT RDCARD SETNOD
Argument List:	IRET - not used NSET1 - array of requested set values NSET2 - first temporary scratch array for set processing NSET3 - second temporary array for set processing NR - number of 2 noded element data values NT - number of other element data values NO - number of nodes returned from SETNOD ISW - switch to check if an automatic return to the DISPLAY module occurs
Important Variables:	Same as argument list

Common Blocks:	BLANK	PERM	TRACK1	PINFLA
	CHAR	TEMP	PLOTCM	MATL
	READ			

Subroutine:	SETNOD
Algorithm:	Routine generates node sets. It processes each valid command separately. First it obtains all the nodes if the ALL command was used. Next it processes the nodes based on a list of node numbers. The routines to do the CYLINDER, SPHERE, SLAB, and BOX commands are then called. Finally, the SETS routine is called to process the union, intersection or exclusion commands and the definition of nodes by suppression type is performed.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** COORDINATE AXIS ________ NOT FOUND FOR BOX
	*** SET ________ DOES NOT PREVIOUSLY EXIST
	*** INVALID OPERATION SPECIFIED FOR NODE SET
	*** INVALID OPERATION FOR NODE SETS
	*** FREEDOM INDICATOR ________ IS NOT VALID
	*** SET ________ IS A NULL SET

External Calls:

BOX	FREDCK	NUMBER	SLAB	UTLMVW
CHANGE	IFINDN	SETETN	SPHERE	
CYLNDR	IOROUT	SETS	UTLLTG	

Argument List:

NSET1	- array containing the given node set
NSET2	- first scratch array for set processing
NSET3	- second scratch array for set processing
NO	- size of the NSET1 array returned

Important Variables: Same as argument list

Common Blocks:

PERM	BLANK	READ
CHAR	TEMP	

Subroutine:	SETS
Algorithm:	Routine performs the set algebra functions. An input switch is used to transfer to the union, exclusion, or intersection processing area as requested by the user. In all cases sets being processed are brought into core and cycled saving the output as a new set.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** UNION OF SET ________ WITH SET ________ GREATER THAN ALLOWABLE CAPACITY
External Calls:	None
Argument List:	ICODE - command type: union, intersection, exclusion, complement NAME1 - character name of the first set K1 - array containing the first set N1 - number of values in K1 NAME2 - name of the second input set K2 - array for the second set N2 - number of values in the second set NAME3 - not used K3 - output set of values N3 - number of values in array K3 KPR - error return code
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	SETUP
Algorithm:	This routine processes element sets before they are sent to the DISPLAY module. It determines the element types and loads their connectivities into solid and dashed line tables. The solid element types are processed separately due to the three-dimensional nature of those elements.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** THE FOLLOWING NODES HAVE NOT BEEN INPUT A LOCATION _____
External Calls:	IFINDN IOROUT SETUP1 IOPAC
Argument List:	IERR - error return switch NSET1 - input element set to be processed IDDAS - dashed line table IDSOL - solid line table IDDBL - boundary line table for contour plots
Important Variables:	Same as argument list
Common Blocks:	BLANK NASTRN MATL PINFLA ELHEAD PERM TYPE SOLIDS DBREC TEMP TRACK1

Subroutine:	SETUP1
Algorithm:	Routine is called by SETUP to complete the line definition processing for plots. It compresses the solid and dashed line tables by removing duplicate line segments. Finally the boundary line table is re-ordered to optimize its drawing.
Input/Output:	None
Error Messages:	None
External Calls:	IOROUT SORTD
Argument List:	IDOL - solid line table IDAS - dashed line table IDBL - boundary line table NAMES - character name array for the tables
Important Variables:	Same as argument list
Common Blocks:	PERM TEMP

Subroutine:	SHIFT
Algorithm:	Routine shifts NVAR command character strings of NBYTE each so that they are left justified. It strips leading blanks and then packs the remainder of the string.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	LCOMD - CHARACTER*1 array of commands to be shifted NVAR - number of strings to be shifted NBYTE - number of characters in each command
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	SORTD
Algorithm:	Routine performs an in-core sort of a two dimensional array. It starts by reformatting the array so that it can be sorted on the first column only. The routine then cycles through the array placing values in ascending order.
Input/Output:	None
Error Messages:	None
Exterral Calls:	None
Argument List:	JD - 2-dimensional array to be sorted
	N - number of values in array JD
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	SORTQ
Algorithm:	Routine is used to perform an in-core sort of various sized arrays. It sorts an array into ascending order by working through each entry and placing it in position. It then moves the rest of the entry's columns into position.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	ID - array to be sorted
	N - number of rows in ID
	NC - number of columns in ID
	IER - error switch, not used
	NS - column of ID on which to sort
	NL - column length, not used
	FF - scratch array of length N, not used
	A - not used
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine: START

Algorithm: Routine is used to initialize the main program variables and internal counters. It also performs the initial user queries.

Input/Output:

Unit 7 - terminal output for message

RDCARD - free read input routine

IOHEAD - gets the data base header record

Error Messages:

*** INCORRECT TERMINAL TYPE, RE-ENTER

*** PROGRAM TYPE ______ NOT SUPPORTED

*** ERROR *** FILE: _____ DOES NOT EXIST; REENTER

*** ERROR *** OPEN ERROR ON UNIT: _____ STATUS: _____

*** ERROR *** FILE: _____ ALREADY EXISTS: ENTER NEW NAME

External Calls:

RDCARD IOHEAD

ZRAYI START1

Argument List: None

Important Variables:

NWPB - number of words per data base block

NUMBEL - number of element types

Common Blocks:

READ	TYPEN	ELHEAD	TRACK1	HEADPP	PLOTCM
TYPE	PLOT	NOHEAD	MOHEAD	PERM	
DIBAUD	PLOTEL	BLANK	DBREC	SYSTEM	

Subroutine:	START1
Algorithm:	Routine is called by START to set the element label names. They are used to call out the elements and are loaded into the TYPES array based upon the communication mode.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	None
Important Variables:	TYPES - array of element names being loaded MODE - communications mode NUMBEL - number of element types ELMS - array containing all the different element names
Common Blocks:	SYSTEM TYPE

The following block of subroutines are utility routines used throughout the code. The routines in this block are:

UTLBAS
UTLCRS
UTLLTG
UTLMVW
UTLSLS
UTLTRN

Subroutine:	UTLBAS
Algorithm:	Utility routine used to determine vectors for establishing basis directions. It converts the given user nodes or coordinates into a vector.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** KEYWORD _______ NOT VALID FOR BASIS COMMAND
	*** NODE _______ DOES NOT EXIST FOR BASIS COMMAND
	*** INSUFFICIENT TERMS SUPPLIED TO BASIS TO EXECUTE THE VECTOR OPTION
External Calls:	CHANGE IFINDN NUMBER
Argument List:	NC - number of coordinate directions for the vector
	* - alternate return
Important Variables:	Same as argument list
Common Blocks:	READ PERM SYSTEM BLANK

Subroutine:	UTLCRS
Algorithm:	Utility routine used to perform cross product operations for three element vectors, A, B, and C, where A = B X C.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	A - cross product resultant vector B - first input vector C - second input vector
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	UTLLTG
Algorithm:	Utility list generator routine. It decodes the standard TO/BY lists of numbers used throughout the program. It begins by setting counters, checking for the TO and BY keywords before decoding the actual numbers supplied for the list. Once the list is generated the ICODE switch is used to check if each generated list number is a previously defined node number.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** BAD DATA LIST FOR SET ______ OR NUMBER GENERATION
External Calls:	IFINDN NUMBER
Argument List:	HOLD - array of 8 character elements with the list for decoding NVAR - number of elements in HOLD K3 - integer array with the decoded list N3 - number of elements in K3 NAME1 - set name for error messages KPR - error switch ICODE - switch for a final node existence check against the list
Important Variables:	Same as argument list
Common Blocks:	PERM

Subroutine:	UTLMVW
Algorithm:	Utility subroutine used to move words from one matrix to another.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	K2 - number of words to be transferred MATRIX - input array IBUFF - output array
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	UTLSLS
Algorithm:	A utility routine which is used to set an array of one character elements as logical switches. It sets an element defined by the ISWS array to the character 1. The entry point UTLDBP unpacks the ELSWS character array back into the ISWS array.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	ELSWS - CHARACTER*1 array of switches N - number of switches to be set ISWS - packed input array of switches
UTLDBP Entry:	ELSWS, N, ISWS - same as UTLSLS
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	UTLTRN
Algorithm:	Utility routine used to perform coordinate transformations from an input system to the base system. It uses the input coordinate system number to search for a previously defined transformation table to define the required transformation matrix. This matrix then operates on the input values to transform them to the base system.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** COORDINATE SYSTEM ________ NOT FOUND
External Calls:	None
Argument List:	ISYS - input coordinate system number C - values to be transformed
Important Variables:	Same as argument list
Common Blocks:	PERM MATL

The following block of subroutines are used to perform the X-Y graph functions of the CADS DISPLAY module. They retrieve data, establish the scales and grids, and perform the required output to the terminal. The routines in this block are:

XYDISP
XYERR
XYGRAF
XYGRID
XYHLBL
XYLGND
XYLINE
XYLSYM
XYMXN
XYSCL
XYSYM
XYTERM
XYTICL
XYTIME
XYTLBL
XYVLBL
ZRAYB

Subroutine:	XYDISP
Algorithm:	Routine retrieves the requested displacement or eigenvector data based on the component number, case, and node list for a particular x-y plot. Retrieval data is stored in the VALUES array and passed back to XYGRAF for the actual display.
Input/Output:	Unit 7 - terminal output for messages IODB - post data base reads IOPAC - packed data I/O to the data base
Error Messages:	*** NO LOAD CASES STORED FOR ______ DATA ** *** ERROR *** LOAD CASE _____ DOES NOT EXIST FOR _____ DATA
External Calls:	IODB IOPAC
Argument List:	NL - number of nodes in NLIST NLIST - list of nodes to be retrieved ICRV - curve number ISW - type of values, 1 = x; 2 = y IWANT - component number of data to be retrieved LCASE - case number NBTYPE - displacement or eigenvector type of data VALUES - array to hold retrieval data values
Important Variables:	Same as argument list
Common Blocks:	MATL HEADPP D1TOKD DBREC PLOTBD

Subroutine:	XYERR
Algorithm:	Routine prints error messages prior to x-y graph outputs. It checks the error number and prints out the appropriate message to unit 7. This helps to flag input or setup errors.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** ERROR: DIFF. BETWEEN MIN. AND MAX. < 1.0E-13 ***
External Calls:	None
Argument List:	IERR - error number switch
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYGRAF
Algorithm:	Routine plots an x-y graph with up to five different curves. First it prompts for user inputs to define the number of curves, data points, and labels. Next it determines minimum and maximum values and sets up the terminal for output. Finally it cycles through special purpose routines to output the titles and curves.
Input/Output:	Unit 5 (INDEV) - terminal input unit for user commands Unit 6 (OUTDEV) - terminal output unit for program prompts Unit 7 - terminal output for messages IODB - performs I/O directly to the data base IOPAC - performs packed data I/O to the data base
Error Messages:	*** ERROR *** OPTION _____ NOT VALID: REENTER *** ERROR *** NUMBER OF CURVES _____IS GREATER THAN 5 *** WARNING * NUMBER OF CASES ___ WAS MORE THAN 60 *** WARNING * NUMBER OF CASES ___ DOES NOT EQUAL NUMBER OF CURVES _____ *** ERROR *** NUMBER OF VALUES DEFINED _____ DOES NOT EQUAL NUMBER OF CURVES _____ *** ERROR *** KEYWORD _____ NOT VALID: REENTER LINE *** ERROR *** NODE SET _____ IS EMPTY: REENTER LINE *** ERROR *** EITHER TIME STEPS HAVE NOT BEEN SET OR THERE IS NO TIME HISTORY DATA ON THE POST DATA BASE

External Calls:

JBEAM	JVPORT	JWINDO	XYLGND	XYSCL	JLSTYL	XYHLBL
XYSYM	JCLOSE	JDRAW	JMOVE	XYGRID	XYMXN	XYTLBL
RDCARD	NUMBER	UTLLTG	XYTERM	PLTBEG	JOPEN	XYVLBL
PLTDOP	JKEYBD	JFRAME	IOROUT	CHANGE	IOPAC	IFINDN
IODB	XYTIME	XYDISP	XYLINE			

Argument List: None

Important Variables:

CDATA - array with curve values

NUMCRV - number of curves

NUMPTS - number of points per curve

CRVNUM - curve number being output

Common Blocks:

D1TOKD	PERM
BLANK	DBREC
READ	HEADPP

Subroutine:	XYGRID
Algorithm:	Routine plots a grid line for each of the x and y axis tic marks. First it plots the border line and then cycle through the tic mark arrays and draws the grid lines.
Input/Output:	None
Error Messages:	None
External Calls:	JDRAW JLSTYL JMOVE
Argument List:	XTICS - array of x tic values YTICS - array of y tic values NXTICS - number of x tics NYTICS - number of y tics XMIN - the minimum of the x values XMAX - the maximum of the x values YMIN - the minimim of the y values YMAX - the maximum of the y values
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYHLBL
Algorithm:	Routine outputs a horizontal label text string. Moves to the desired position and outputs an input string based upon the number of characters to be output.
Input/Output:	None
Error Messages:	None
External Calls:	JMOVE J1STRG
Argument List:	NHCHAR - number of characters in the label ILABEL - array with the label characters (72 characters) IHLABL - array with up to 48 characters IXPOS - x start position on the screen IYPOS - y start position on the screen
Important Variables:	Same as argument list
Common Blocks:	None

<u>Subroutine</u>:	XYLGND
<u>Algorithm</u>:	Routine outputs the legend block for the x-y plot. It draws the border, plots the heading labels and finally outputs the individual curve legends.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	JDRAW XYLSYM JMOVE J1STRG
<u>Argument List</u>:	NUMCRV - number of curves to be plotted
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine:	XYLINE
Algorithm:	This routine sets the dashed line style for each of the curves to be plotted. It cycles through the curves, setting the line type.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	CRVNUM - curve number LINTYP - line type for the curve
Important Variabled:	Same as argument list
Common Blocks:	None

Subroutine:	XYLSYM
Algorithm:	This routine places the curve symbol at a desired location. It uses the curve number to determine the current symbol. It is used for the symbols in the legend box.
Input/Output:	None
Error Messages:	None
External Calls:	JCMARK JMARK
Argument List:	CRVNUM - curve number IX - x screen position for the mark IY - y screen position for the mark
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYMXN
Algorithm:	Routine determines the minimum and maximum values in a one dimensional array. It uses a straight search through the array values to determine these values.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	XMIN - minimum array value XMAX - maximum array value ARRAY - array of values NUMB - number of values in ARRAY
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYSCL
Algorithm:	Routine scales the curve values so that even increments based upon 1.0, 2.0, 2.5, or 5.0 to powers of 10 are obtained. First it scales the x-values based upon the minimum and maximum x's using common logs and powers of 10 to divide the x-distance. The final scale value is used to determine the corresponding tic marks. This process is then repeated for the y-axis values.
Input/Output:	Unit 7 - terminal output for messages
Error Messages:	*** ERROR: DIFF. BETWEEN MIN. AND MAX. <1.0E-13**
External Calls:	XYERR
Argument List:	XMIN - minimum x axis value
	XMAX - maximum x axis value
	YMIN - minimum y axis value
	YMAX - maximum y axis value
	XTICS - x tic mark value array
	YTICS - y tic mark value array
	FLAG - error flag switch
	NXTICS - number of x tic marks
	NYTICS - number of y tic marks
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYSYM
Algorithm:	Routine outputs a curve symbol along the curve as it is plotted. It sets the correct mark and outputs the symbol using the curve number to get the current mark.
Input/Output:	None
Error Messages:	None
External Calls:	JCMARK JMARK
Argument List:	CRVNUM - curve number X - x screen position of the mark Y - y screen position of the mark
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYTERM
Algorithm:	This routine performs x-y graphing for user supplied sets of x and y values. It prompts the user for the curve titles and the sets of x and y values to be graphed. It then determines the correct tic marks and grid lines before finally cycling through the values to plot the required curves.
Input/Output:	RDCARD - free read terminal input Unit 5 - terminal input Unit 6 - terminal output Unit 7 - terminal output for messages
Error Messages:	*** ERROR *** NUMBER OF X VALUES _____ MUST EQUAL NUMBER OF Y _____
External Calls:	CHANGE JDRAW JLSTYL JVPORT PLTDOP XYHLBL JBEAM JFRAME JMOVE JWINDO RDCARD XYLGND JCLOSE JKEYBD JOPEN PLTBEG XYGRID XYLINE XYMXN XYSCL XYSYM XYTLBL XYVLBL
Argument List:	None
Important Variables:	NUMCRV - number of curves to be processed CRVNUM - number of the particular curve being processed CDATA - array with the x,y values to be graphed JDATA - pointer array describing the size of each curve
Common Blocks:	None

Subroutine:	XYTICL
Algorithm:	Outputs the tic mark labels along the x and y axes. Checks for the axis direction, converts the value at the mark into characters and then outputs the characters.
Input/Output:	None
Error Messages:	None
External Calls:	JMOVE J1STRG
Argument List:	X - x screen position of the mark Y - y screen position of the mark VALUE - tic mark value
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	XYTIME
Algorithm:	This routine retrieves the node displacements or eigenvectors by time step number for x-y graphs. First it finds the correct data table headers and then retrieves the pointer records for the input node list. Finally the routine cycles through the data values placing the appropriate values into the output array.
Input/Output:	IOPAC - packed data base I/O Unit 7 - terminal output for messages
Error Messages:	*** NO LOAD CASES STORED FOR _____ DATA *** *** ERROR *** LOAD CASE _____ DOES NOT EXIST FOR ____ DATA
External Calls:	IODB IOPAC
Argument List:	NLIST - node number to define data to be retrieved ICRV - curve number being processed ISW - switch for values: 1, x values; 2, y values IWANT - the data component to be retrieved (i.e., TX, TY, etc) NCASE - the load case number NCASES - list of the load case numbers NBTYPE - swtich for displacement or eigenvector data VALUES - output array with values to be graphed
Important Variables:	Same as argument list.
Common Blocks:	MATL HEADPP D1TOKD DBREC PLOTBD

Subroutine:	XYTLBL
Algorithm:	Routine determines the tic mark line positions and converts them to output coordinate locations.
Input/Output:	None
Error Messages:	None
External Calls:	XYTICL
Argument List:	XTICS - x tic mark value array NXTICS - number of x tic marks YTICS - y tic mark value array NYTICS - number of y tic marks
Important Variables:	Same as argument list
Common Blocks:	None

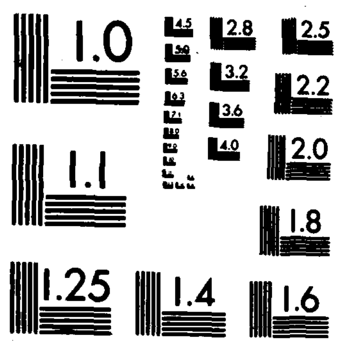
<u>Subroutine</u>:	XYVLBL
<u>Algorithm</u>:	Routine outputs the vertical axis label. It moves to the start position and outputs the title down the screen.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	JMOVE J1STRG
<u>Argument List</u>:	IVLBL - array of characters in the label
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine:	ZRAYB
Algorithm:	This routine is used to zero out input matrices. The entry point ZRAYI zeroes out integer matrices.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	AA - real matrix to be zeroed N - number of values to be reset
ZRAYI ENTRY	NA - integer matrix to be zeroed N - same as ZRAYB
Important Variables:	Same as argument list
Common Blocks:	None

The following block of subroutines makes up the CADSPP software used to read analysis output to the POST data base for use by the CADS software. The routines in this block are:

POST
TYPEVA, HEADTI
IODB
IOPAC
RDANAL
RDOPTS
RDPCHT
RDPCH1
RDPCH2
RDPCH3
RDSTDE
RDSTD1
RDSTD2
RDSTFS
RDSTF1
RDSTF2
RDSTF3
RDSTF4
SHPPVA
STARTP
VARRAY
WRMAST

Main:	POST
Algorithm:	This is the main program module for the CADSPP POST data base loading program. It opens the message file on unit 7 and then calls in the operational routines.
Input/Output:	Unit - 7 for terminal output messages
Error Messages:	None
External Calls:	RDPCHT RDPCH1 RDOPTS STARTP RDANAL
Argument List:	None
Important Variables:	NPROG - type of analysis data to be loaded
Common Blocks:	READ DBREC MASTER TYPEVA HEADER TITLES HEADTI BLANK NODEL



1.0
4.5
5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

Block Data:	TYPEVA/HEADTI
Algorithm:	This block data module initializes the TYPEVA and HEADTI common blocks. The NCFS array is initialized with the NASTRAN element type, CADS element type, number of forces, and number of stresses per element type. The TYPE array is initialized with the key command type words for NASTRAN analysis decks and the OPTION array contains the names of the valid analysis types supported by CADSPP.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	None
Important Variables:	NCFS - 4 X 25 array for storing counters TYPE - type values for decoding the input cards OPTION - array containing the supported data types
Common Blocks:	TYPEVA HEADTI

<u>Subroutine</u>:	IODB
<u>Algorithm</u>:	This subroutine performs the direct access I/O to the POST data base. The input switch IG defines the operation to be performed. The buffer array A and record number IREC are then used to retrieve or store the given information.
<u>Input/Output</u>:	NUNIT - unit used for direct access I/O
	Unit 7 - terminal output for messages
<u>Error Messages</u>:	*** _____ REQUEST ERROR FROM SUB. _____ ON UNIT _____
<u>External Calls</u>:	None
<u>Argument List</u>:	IG - read/write switch for the subroutine
	A - array of data for data base I/O
	N - number of elements in A
	IREC - direct access record number for I/O
	NUNIT - direct access unit number
	SUBNAM - name of the calling subroutine
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

<u>Subroutine</u>:	IOPAC
<u>Algorithm</u>:	This routine packs an array of information for sending to the data base. It blocks the data to the record size of the data base and calls IODB to perform the actual I/O function.
<u>Input/Output</u>:	IODB - actual data base I/O
<u>Error Messages</u>:	None
<u>External Calls</u>:	IODB
<u>Argument List</u>:	ARRAY - array with data for I/O
	NWRD - number of words to be stored or retrieved
	IG - switch to read or write data: 1 read; 2 write
	NDBUNT - data base unit number
	SUBNAM - name of the calling routine; passed to IODB
<u>Important Variables</u>:	Same as argument list.
<u>Common Blocks</u>:	DBREC

Subroutine:	RDANAL
Algorithm:	This routine reads and stores the analysis results from the ANALYZE program. It decodes the command cards; reads in all of the displacement values, and then outputs those values to the POST data base. The stress data is then read and stored. The results are stored to the POST data base so that they look similar to NASTRAN results.
Input/Output:	Unit 7 - terminal output for messages IODB - data base I/O IOPAC - packed data base I/O NASTPU - input unit for analysis data
Error Messages:	** ERROR ** E-O-F ON UNIT _____ SEARCHING _____ DATA
External Calls:	IODB VARRAY IOPAC WRMAST
Argument List:	None
Important Variables:	NCASES - number of load cases in analysis results MASTER - master header record array NELEM - number of elements in the model DISP - data array of displacements STRES - data array of stresses
Common Blocks:	READ BLANK DBREC TYPEVA TITLES MASTER HEADTI HEADER

<u>Subroutine</u>:	RDOPTS
<u>Algorithm</u>:	This routine reads and stores the analysis results from the OPTSTAT program. It is very similar to the RDANAL routine with some minor differences for the OPTSTAT result formats. The displacement data is stored followed by the stress results.
<u>Input/Output</u>:	Unit 7 - terminal output for messages IODB - data base I/O IOPAC - packed data base I/O NASTPU - input unit for analysis data
<u>Error Messages</u>:	** ERROR ** E-O-F ON UNIT _____ SEARCHING _____ DATA
<u>External Calls</u>:	IODB VARRAY IOPAC WRMAST
<u>Argument List</u>:	None
<u>Important Variables</u>:	NCASES - number of load cases in analysis results MASTER - master header record array NELEM - number of elements in the model DISP - data array of displacements STRES - data array of stresses
<u>Common Blocks</u>:	READ BLANK DBREC TYPEVA TITLES MASTER HEADTI HEADER

Subroutine:	RDPCHT
Algorithm:	This routine reads the title and header cards from the NASTRAN output punch file for decoding and processing by other routines. Once a valid data type is found a decoding routine is called and the appropriate node or element data is stored.
Input/Output:	NASTPU - unit with NASTRAN analysis results data Unit 7 - terminal output for messages
Error Messages:	ELEMENT TYPE __________ IS NOT SUPPORTED BY THE PROGRAM
External Calls:	IOPAC WRMAST RDSTDE RDSTFS
Argument List:	None
Important Variables:	NHEAD - header array for POST data base NOCOND - number of load cases NELTYP - element type number being processed
Common Blocks:	READ BLANK DBREC TYPEVA TITLES MASTER HEADTI HEADER

Subroutine:	RDPCH1
Algorithm:	This routine calls in the element or node NASTRAN output read routine for dynamic data. It switches between processing element or node data and then it calls in the appropriate decoding routine. Finally, the routine saves the time increments and header records to the POST data base.
Input/Output:	IOPAC - packed data base I/O NPPUNT - POST data base write of new record
Error Messages:	None
External Calls:	IOPAC RDSTD1 RDSTF1 RDPCH2 RDSTD2 RDSTF2
Argument List:	None
Important Variables:	None
Common Blocks:	NODEL MASTER HEADER DBREC

Subroutine:	RDPCH2
Algorithm:	This routine provides dynamic NASTRAN analysis result processing for CADSPP. It decodes the NASTRAN cards for valid card types and sets up the pointers for storing the result values based upon those cards and the user supplied requests.
Input/Output:	INPUNT - input unit for NASTRAN analysis data Unit 7 - terminal output for messages NPPUNT - POST data base write
Error Messages:	ELEMENT TYPE _____ IS NOT SUPPORTED BY THE PROGRAM
External Calls:	RDPCH3
Argument List:	None
Important Variables:	TYPE - array of valid analysis output card types IREQ - array with user requested data types NCFS - array with the valid element types and their pointers
Common Blocks:	READ TITLES DBREC TYPEVA NODEL HEADTI HEADER

Subroutine:	RDPCH3
Algorithm:	This routine reads in the actual NASTRAN analysis data values for a particular node or element. It determines the number of data cards to be read and then places the data values into the TIME output array.
Input/Output:	INPUNT - card input of NASTRAN results Unit 7 - terminal output for messages
Error Messages:	** ERROR ELEMENT OR POINT ID IS NOT ON INPUT FILE **
External Calls:	None
Argument List:	NV - number of data values to be read
Important Variables:	Same as argument list
Common Blocks:	READ DBREC HEADTI NODEL

Subroutine:	RDSTDE
Algorithm:	This routine reads and stores the node displacement and eigenvector data from NASTRAN. First it checks that the required subcase is found and then it checks for the correct data type. Next it reads the values card by card and compresses them into an output record for storage in the POST data base. Finally the routine updates the header record.
Input/Output:	IODB - routine performs actual direct access I/O NASTPU - NASTRAN output information unit Unit 7 - terminal output for messages
Error Messages:	*** ERROR SUBCASE FOR DISP OR EIGEN IS NOT ON TAPE *** *** ERROR EIGENVALUE IS NOT ON INPUT TAPE *** *** ERROR INCOMPLETE INPUT FOR NODE = _____ COND NO = _____ *** ERROR END OF FILE ON INPUT WHEN ATTEMPTING TO READ DISPLACEMENTS OR EIGENVECTORS ***
External Calls:	IODB VARRAY WRMAST
Argument List:	IDSP - array holds the integer values for the node outputs DSP - array holds the real values for the node outputs IG - switch for the data type being processed IEND - end of file indicator
Important Variables:	Same as argument list

Common Blocks:		
	READ	DBREC
	HEADTI	HEADER
	TITLES	MASTER

Subroutine:	RDSTD1
Algorithm:	This routine reads a set of dynamic displacement values for one node and decodes the values from characters into the appropriate program variables.
Input/Output:	INPUNT - input unit with NASTRAN results Unit 7 - terminal output for messages INPT - scratch output unit
Error Messages:	*** ERROR POINT ID IS NOT ON INPUT TAPE *** ** ERROR INCOMPLETE INPUT FOR NODE = _____ *** ERROR E-O-F ON UNIT ____ WHEN READING DISPLACEMENTS ***
External Calls:	None
Argument List:	IG - data type to be processed INPT - scratch file
Important Variables:	Same as argument list
Common Blocks:	READ HEADTI DBREC

Subroutine:	RDSTD2
Algorithm:	This routine reads the dynamic displacements or eigenvectors from the scratch file and stores them to the POST data base. It reads and packs the data values into records, updates the pointer records based on the time step, and finally stores the data values to the POST data base.
Input/Output:	IODB - direct access data base I/O IT1 - input scratch unit IT2 - output scratch unit
Error Messages:	None
External Calls:	IODB WRMAST
Argument List:	IG - type of data to be stored IT1 - input scratch file IT2 - output scratch file
Important Variables:	Same as argument list
Common Blocks:	NODEL HEADER BLANK MASTER DBREC

Subroutine:	RDSTFS
Algorithm:	This routine processes the element stress and force data. It reads in the data values and stores them in a buffer array before calling IOPAC for output to the POST data base. Finally it updates the header record and returns.
Input/Output:	IOPAC - packs data array for output to direct access file NASTPU - unit with NASTRAN output file Unit 7 - terminal output for messages
Error Messages:	*** ERROR INCOMPLETE INPUT FOR TYPE = _____ COND NO = _____ EL. ID = _____
External Calls:	IOPAC
Argument List:	IDSP - buffer array for integer values DSP - buffer array for real values N - number of values in DSP or IDSP NV - number of values per element and data type NCTYPE - CADS program element type number IG - switch for the type of data being processed IEND - end of file switch
Important Variables:	Same as argument list
Common Blocks:	READ TITLES MASTER TYPEVA DBREC HEADTI HEADER

Subroutine: RDSTF1

Algorithm: This routine decodes the dynamic stress or force data. First it checks the NASTRAN analysis cards for validity and then determines the number of data components for the particular analysis data type and element type being processed. Finally it reads the actual data values and writes them to the scratch file.

Input/Output:

INPUNT - NASTRAN analysis card input
INPT - scratch file unit
Unit 7 - terminal output for messages

Error Messages:

```
**  ERROR ELEMENT TYPE NOT ON INPUT FILE  **

**  ERROR ELEMENT ID IS NOT ON INPUT FILE **

**  ERROR INCOMPLETE INPUT FOR TYPE = ____ ID = ____ **
```

External Calls: None

Argument List:

IG - type of data block being processed, 1=Forces, 2=Stresses
INPT - scratch file

Important Variables: Same as argument list

Common Blocks:

READ DBREC
TYPEVA
HEADTI

Subroutine:	RDSTF2
Algorithm:	This routine reads in the data values for dynamic stresses or forces from a scratch unit and formats them for output to the POST data base. It cycles through the data values, sets up the counters for them, and finally updates the pointer records for the element data.
Input/Output:	IT1 - input scratch unit IT2 - output scratch unit
Error Messages:	None
External Calls:	RDSTF3 RDSTF4 WRMAST
Argument List:	IG - type of data being processed IT1 - input scratch array IT2 - output scratch array
Important Variables:	Same as argument list
Common Blocks:	NODEL HEADER BLANK MASTER DBREC

<u>Subroutine</u>:	RDSTF3
<u>Algorithm</u>:	This routine packs a column of a two dimensional array with a one dimensional vector of values.
<u>Input/Output</u>:	None
<u>Error Messages</u>:	None
<u>External Calls</u>:	None
<u>Argument List</u>:	IDSP - two dimensional output array
	NVP1 - number of rows in IDSP
	IVAL - one dimensional vector to be placed in IDSP
	ITOT - column of IDSP to be filled by IVAL
<u>Important Variables</u>:	Same as argument list
<u>Common Blocks</u>:	None

Subroutine:	RDSTF4
Algorithm:	This routine stores the dynamic stress or force information directly to the POST data base. It updates the master pointer record and then calls IOPAC to store the data value array to the data base.
Input/Output:	IOPAC - packed data base I/O
Error Messages:	None
External Calls:	IOPAC
Argument List:	IDSP - stress or force data value array
	NVP1 - number of components per element type
	ITOT - NASTRAN type number for the element
	NCTYPE - CADS type number for the element
	M - record number
	IG - type of input data: 1=forces; 2=stresses
Important Variables:	Same as argument list
Common Blocks:	DBREC
	MASTER

Subroutine:	SHPPVA
Algorithm:	This routine packs a user input card for processing in the STARTP routine. Basically it removes blanks from between variables and places the compressed values back into the HOLD array.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	HOLD - buffer of 8 character input variables
	LHOLD - overlaid on HOLD but stored as 8, 1 character values
	NVAR - number of variables in HOLD
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	STARTP
Algorithm:	This routine is the initialization and control routine used to process the analysis outputs for storage on the POST data base. It initializes switches and counters; prompts for input commands; and returns to the main control routine for later processing of the actual values.
Input/Output:	Unit 7 - terminal output for messages Unit 5 - input unit for user
Error Messages:	*** ERROR *** FILE _____ DOES NOT EXIST: REENTER *** ERROR *** OPTION _____ IS NOT VALID; REENTER *** ERROR *** FILE _____ AND EXISTENCE STATUS DO NOT MATCH; REENTER *** ERROR *** _____ TYPE DATA ALREADY ON POST DATA BASE DOES NOT MATCH REQUESTED ____ DATA TYPE ** NO SPACE IN THE HEADER RECORD COND. LIMIT IS 61 ** *** ERROR INDICATE INPUT TYPE STATIC OR DYNAMIC *** *** ERROR *** END OF DATA STATUS= _____ *** ERROR *** OPEN ERROR ____ ON FILE: _____
External Calls:	IOPAC SHPPVA VARRAY
Argument List:	IPASS - switch for multiple input data sets

Important Variables: None

Common Blocks:	HEADTI	HEADER	DBREC
	TITLES	MASTER	

Subroutine:	VARRAY
Algorithm:	This routine is used to initialize an array to a given value.
Input/Output:	None
Error Messages:	None
External Calls:	None
Argument List:	AA - array to be initialized N - number of array elements to be initialized V - value to be used for initialization
Important Variables:	Same as argument list
Common Blocks:	None

Subroutine:	WRMAST
Algorithm:	This routine is used to store the master header record to the POST data base. It stores the master record pointers into the header record and calls IODB to write the record to the data base.
Input/Output:	IODB - direct access file I/O.
Error Messages:	None
External Calls:	IODB
Argument List:	MCOND - number of entries in the master record MASTER - master record NTYPE - master record data type
Important Variables:	Same as above
Common Blocks:	TITLES DBREC HEADER

6.0 ERROR MESSAGES

The CADS software will attempt to recover from input or processing errors in one of several different ways. The type and severity of the error will define the error handling procedure to be used by CADS.

The most common errors are generally mistypings of command words, options, or parameters. In these cases, CADS will say that option or command was not found or is not valid and ask that the entire command line be re-entered. The user should then enter the entire line with the correct spellings and options.

CADS will check parameter numeric values for real or integer numbers as required. If an incorrect or mistyped numeric value is entered, CADS will echo the character string and ask that a real or integer number be entered. In these cases the user should enter the numeric values only and not the entire command line.

Finally, the DI-3000 graphics package may issue a warning or error message based upon some series of actions it is taking. The level at which errors will be printed out and the unit on which they will be printed can be changed by the CADS software maintenance personnel. The JSETER and JFILES routines control the DI-3000 error messages. Typically, DI-3000 will continue processing after an error message through its own internal routines. The CADS command may have to be re-entered and/or modified to obtain a correct display after a DI-3000 message since DI-3000 may not have taken the appropriate action in processing the given error.

7.0 REFERENCES

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